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GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.

REPORTS

OF

EXPLORATIONS AND SURVEYS.

1879-80.

B

TO THE RIGHT HONORABLE

SIR JOHN A. MACDONALD, P.C., K.C.B.

Minister of the Interior.

SIR,—I have the honor to transmit, for the information of His Excellency the Governor-General in Council, the customary annual reports relating to the progress of the Geological and Natural History Survey of Canada during the year 1879-80.

I have the honor to be,

Sir,

Your obedient servant,

ALFRED R. C. SELWYN.

May, 1881.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.

ALFRED R. C. SELWYN, LL.D., F.R.S., DIRECTOR.

REPORT OF PROGRESS

FOR

1879-80.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

Montreal:
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1881.

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REPORT B: (III.)

Page 6, *line* 13 *from top, for* "about 80,°" *read* "above 80.°"
" 11, *line* 1 *from bottom, for* "valley and appears," *read,* "valley which appears.'
" 13, *line* 2 *from top, for* "with steep and banks," *read* "with steep banks and."
" 15, *line* 9 *from bottom, for* "Hadias" *read* "Haidas."
" 25, *line* 13 *from bottom, after* "Omenica River" *add* "and the trail from."
" 27, *line* 7 *from bottom, for* "in," *read* "is."
" 33, *line* 17 *from top, after* "2,200," *add* "fect."
" 34, *line* 17 *from bottom, for* "*Picea Engellanni*," *read* "*Picea Engelmanni*."
" 44, *line* 8 *from bottom, for* "obtain," *read* "attain."
" 49, *line* 22 *from top,* et passim, *for* "Pouce Coupée," *read* "Pouce Coupé."
" 54, *line* 3 *from bottom,* et passim, *for* "Isle de Montagne," *read,* "Ile de Montagne."
" 57, *line* 13 *from top, for* "*bocannes*," *read* "*boucans*."
" 58, *line* 8 *from bottom,* et passim, *for* "Lac des Isles" *read* "Lac des Iles."
" 68, *line* 9 *from bottom, for* "These forests," *read* "This forest."
" 74, *line* 11 *from top, for* "with," *read* "and."
" 75, *line* 9 *from bottom, for* "360,800,000," *read* "302,800,000."
" 107, *line* 2 *from top, for* "Pin-che," read "Pin-chi."
" 121. *line* 8 *from top, for* "rhachis," *read* "rachis."
" 137, *line* 2 *from top, for* "Sip-ki-wa," read "Sip-ki-aw."
" 140, *line* 2 *from bottom, after* "3,300," *read* "feet."
" 165, *line* 4 *from top, for* "July," *read* "June."

REPORT C. (IV.)

Page 8, 4*th line from top, for* "North," *read* "Nelson."
" 14, 1*st line from top, for* "from Churchill," *read* "from the Churchill."
" 14, 9*th line from top, for* "is," *read* "are."
" 14, 16*th line from top, for* "stream," *read* "side."
" 16, 11*th line from bottom, for* "Tatman," *read* "Tatnam."
" 30, 6*th lnie from top, for* "apparent," *read* "apparently."
" 30, 21*st line from bottom, for* "1772," *read* "1782."
" 30, 13*th line from bottom, after* "tide," *add* "amounting to 38½ feet at Fort Chimo."
" 43, 21*st line from bottom, for* "geological," *read* "geographical."

REPORT D. (V.)

Title page, for "1881," *read* "1880."
Page 3, *line* 13*th from bottom, for* "1837," *read* "1857."
" 1, *line* 18*th from bottom, for* "Minas Basin," *read* "Waugh's River."
" 9, *line* 3*rd from bottom, for* "Erl River," *read* "Eel River."
" 19, *line* 23*rd from bottom, for* "inst.," *read* "west."
" 37, *line* 12*th from bottom, for* "dolerites," read "diabase," in this and subsequent pages.

REPORT F. (VI.)

Page 1, *in heading*, 3rd *line*, *for* " part " *read* " parts."
" 8, *in margin*, 1*st note*' *for* " Prihgle," *read* " Fringle."
" 8, 3*nd line*, *for* " follows," *read* " follow."
" 46, 29*th line*, *for* " bursts,' '*read* " burst."
" 54, 40*th line*, *for* " Leaia Leidyii," *read* " Leaia Leydi."
" 62, 10*th line*, *for* " Leaia Leidyii," *read* " Leaia Leydi."
" 65, 18*th line*, *for* *Amelanchier* *read* (*Amelanchier*.)
" 89, 5*th line*, *for* " n," *read* " in."
" 106, *in margin*, 1*st note*, *for* " Ique," *read* " Judique''
" 112, *in margin*, 4*th note*, *for* " blown-down," *read* " blow-down."
" 113, *in margin*, 3*rd note*, *for* " landslidess," *read* " lanslides."

ADDITIONAL ERRATA.

LIST OF PLATES.

Plate 20. Bald Mountain, looking up Nipisiguit River, N.B. Page 36 D.

REPORT A. (I.)

Page 5, *line* 8 *from bottom*, *for* " Appendix II.," *read* " Appendix I."

SUMMARY REPORT

OF THE

OPERATIONS OF THE GEOLOGICAL CORPS.

TO 31ST DECEMBER, 1880.

BY

ALFRED R. C. SELWYN, L.L.D., F.R.S.,

DIRECTOR OF THE GEOLOGICAL AND NATURAL HISTORY SURVEYS OF CANADA.

The work of the Geological Corps during the season of 1880 embraced explorations and surveys in :—

1. The North-West Territories; Souris River Coal Fields. Districts examined.
2. Manitoba. (Hudson's Bay Basin.)
3. Quebec; on both sides of the St. Lawrence.
4. New Brunswick.
5. Nova Scotia.
6. The Magdalen Islands.

No field work was done during the season of 1880 in British Columbia, British Columbia. Dr. G. M. Dawson being occupied in the early part of the year in working up the results of his Peace River Expedition of 1879, and during the Director's absence in the North-West in May, June and July, in attending to correspondence, and to the printing of the Annual Report. In August he received leave of absence to attend the meeting of the British Association and to visit the Continent. Returning early in November, he has since been occupied with the printing of his report on the Peace River explorations, and the preparation of the map to accompany it. This map embraces all the available information regarding a region about 130,000 square miles in extent, from the Pacific Ocean to the 112th meridian, and from the 54th to the 57th degree of north latitude. Considerable time has also been devoted to arranging specimens from British Columbia previous to packing them for removal to Ottawa.

The report and map above referred to form a part of the present volume, and will be found to embody the best and most reliable information regarding this vast and interesting region.

The North West Territories.

In March, 1880, it was decided to make an investigation by boring to obtain more precise information respecting the Tertiary lignite-coal seams of the Souris River, more especially as regards their eastern extension from the known outcrops in the vicinity of Roche Percée. With this object in view, a contract was entered into with Messrs. McGarvey & Highman, of Petrolia, Ontario, to make two or more borings in the valley of the Souris River, the aggregate depth not to exceed 800 feet, for the sum of six thousand dollars; the sites, not more than 25 miles apart, to be selected after a careful examination of the ground. This examination was undertaken by the writer, and occupied him from the 13th May to the 30th August. Expenses, $1,204.30.

Souris River borings.

The boring commenced about seven miles east of the Roche Percée on the 12th July, and finished on Turtle Mountain on the 6th October, 1880. The details of this work are given in the accompanying report (A), and also as closely pertaining to it, the report of Dr. G. M. Dawson on his examination of the same district in connection with the International Boundary Survey. This was first published in 1874. * The volume referred to is now out of print. It has, therefore, been considered desirable to reprint here that portion of it which relates more especially to the distribution and value of the Tertiary lignite coal beds of this region; and for this purpose it has been revised and partly re-written by Dr. Dawson. Vide Appendix I.

Hudson's Bay basin.

Dr. Robert Bell, with Mr. Cochrane as assistant, and Messrs. Molson and Langford, volunteers, left Montreal early in June, with instructions to continue his explorations of previous seasons in the Hudson's Bay basin, and if practicable to return to Canada by proceeding in the Hudson's Bay Company's ship from Churchill or York Factory to London, with a view of making observations on the navigation of the Hudson's Bay and Straits. This, through the kind assistance and facilities afforded by the officers of the Company, Dr. Bell has accomplished. The passage, owing to calms in the straits, and head winds on the Atlantic, occupied from the 10th September to the 17th November, or nearly three times the average duration. The three weeks during which the vessel was passing through the straits afforded good opportunities for observing both shores in many places, as well as the islands. Dr. Bell returned to Montreal on the 14th February, 1881, and his report now presented contains full particulars of the season's explorations, which cost $1,945.35. This report and the annexed weather statistics

* Geology and Resources of the 49th Parallel, by G. M. Dawson

will be found especially interesting in connection with the navigation of Hudson's Bay and the oft stated impossibility* of constructing a railway to Forts Churchill or York from Manitoba.

Quebec. Explorations of Mr. Vennor.

In the Province of Quebec, on the north side of the St. Lawrence, explorations were continued by Mr. Vennor in the counties of Argenteuil, Terrebonne, Montcalm and Jolliette, embracing about 900 square miles. A number of details of interest and importance in connection with the distribution of the bands of crystalline limestone and the labradorite rocks were ascertained; and in association with the latter promising deposits of iron ore were discovered at a number of new points, at one of which, near St. Jerome village, a considerable amount of work has since been done by a United States company with a view to its development. Mr. Vennor's exploration occupied from the 2nd June to 27th November; expenses, $909.43.

In anticipation of a final report promised by Mr. Vennor, giving the detailed results of his two seasons' work in this region, the following statement of the general conclusions he has arrived at may be given:

"In these explorations, perhaps, the most important results arrived at were in connection with the bands of crystalline limestone on the western side of the labradorite area, and the junction of these with the great mass of anorthosite rocks already mapped and described by Logan † These limestones, as a whole, appear to be perfectly conformable with the stratified anorthosites, but are occasionally interfered with and disturbed by intrusions (?) of the more massive and granitoid variety of labradorite. This last rock—in which there are no indications of stratification—occupies a very considerable area in the townships of Abercrombie, Howard, Morin, Wexford, Wolf, Beresford and Doncaster. Its exact outline is not easily ascertained, but I have laid down a provisional line that will indicate sufficiently closely the area occupied by it—some 250 to 300 square miles.

Position and character of the Labradorite rocks.

The anorthosite (stratified) formation appears to come in beneath the first or lowest band of limestone (Trembling Lake band) and a very considerable part of "Trembling Mountain" is composed of gneiss of this character.

The St. Jerome band of limestone was discovered at a number of additional localities to the north-westward of the village, and was traced to a connection with that of St. Godfrey and St. Sauveur, and this last through Howard to a junction with the 'Trembling Lake' band in De Salaberry. Between this *lowest* or 'Trembling Lake' band and the *second*, or 'Green Lake' band of Logan there are also occasional

* Statement of the Deputy Governor of the Hudson's Bay Company, annual meeting in London, 1879.
† Geology of Canada, 1863.

recurrences of the granitoid labradorite, and many of these exposures have the general appearance of eruptive rocks. One of these masses has been indicated by Logan as occurring on the north-west corner of De Salaberry; and was here supposed to cover (unconformably) and conceal the further run of the limestone, but we succeeded in tracing this latter continuously around the western side of the former to a connection with the 'Lake Sam' band." *

If the foregoing determinations by Mr. Vennor, which are given in his own words, are correct, they seem very conclusively to prove what I have already stated to be my opinion, viz: that the labradorite or Norian rocks of Hunt do not constitute an unconformable upper Laurentian formation, but occur in part as unstratified intrusive masses, and in part as interstratifications with the orthoclase gneisses, quartzites and limestones of the Laurentian system, as developed in the Grenville region, and mapped by Sir W. Logan.

Explorations of Messrs. Ord and McConnell.

To the east of the region examined by Mr. Vennor, a large area, 1,600 to 1,700 square miles, was examined by Mr. Ord and Mr. McConnell, in the counties of Berthier, Maskinonge and St. Maurice, and 350 miles of road, not shown on any existing plan, were measured by pacing. The Matawin River was examined in canoe from the township of Brassard to the St. Maurice, also its tributaries from the north and northeast: rivers du Millieu, au Lac Claire and à la Chienne, as well as some of the lakes forming the head waters of Rivière du Loup. The greater portion of this area is occupied by almost flat-lying Laurentian gneiss, forming the summit of an anticlinal axis. One band of limestone, supposed to represent the lowest on the west side of the anticlinal, was found on the St. Maurice with an easterly dip, and it seems probable that the higher bands which occur to the west of the great area of massive labradorite in the townships of Howard, Morin, Abercrombie, etc., may yet be discovered east of the St. Maurice River, together with some of the valuable mineral deposits with which they are usually associated. The explorations of Messrs. Ord and McConnell occupied from the 6th June to the 26th September; expenses, \$728.35.

Describing the region of country between the Assomption River and the St. Maurice, Mr. McConnell says: "Among the more important varieties of rock observed in this region may be mentioned gneisses, ordinary grey, garnetiferous, hornblendic, etc., massive red syenite, bedded and massive norites, pyroxenites, and a few more or less impure bands of crystalline limestone.

The syenite spreads over an area of about 100 square miles, extending from St. Norbert to Lac Pin Rouge, a distance of about twenty-five

* See Logan's map, Atlas Geol. of Canada, 1863.
† Geological Survey of Canada, Report of Progress, 1877-78, pp. 10-13 A.

miles. Everywhere it maintains a distinctly massive character, and shows no traces of stratification, though in texture it is far from uniform, being both fine and coarse grained, and in one or two instances the crystals were flattened in such a manner as to give the rock an almost shaly or schistose structure. In one place only was actual contact observed between the syenite and the surrounding gneisses; there the bedded rock dipping at an angle of about 70° appeared to strike against the syenite at an angle of 20° and to be cut off by it.

Norites—Several small bands of the bedded variety of this rock occur between St. Jean de Matha and Lake Maskinonge, all alternating with, and conformable to the gneisses of the region."

On the south side of the St. Lawrence Mr. Webster has made explorations over a large area, about 3,000 square miles, extending from Lake Memphremagog northward and north-eastward along the New Hampshire and Maine boundaries. The whole of this region is auriferous, and no examination had hitherto been made of a large part of it. It seemed very desirable to ascertain more definitely the probable economic value of these auriferous deposits, also to determine the extent of the granitic areas, their relation to the adjacent strata, and the influence of the granitic intrusions on the auriferous character of the surrounding formations, which correspond in all respects with those of some of the richest of the Australian gold fields. The Eastern Townships. Explorations of Mr. Webster.

Another season's work in this region will be required before the distribution of the formations can be correctly laid down. The greater part of the area is occupied by strata of Silurian age, interrupted, however, by others which are apparently repetitions of the crystaline schists of the great Sutton Mountain anticlinal to the north-west, and probably of lower Cambrian or upper Huronian age.

The granites are for the most part pretty uniform mixtures of white orthoclase, quartz and black mica, forming a good and durable building material. Their general characters have already been described by Sir W. Logan.* There is no doubt they are of later origin than the Silurian rocks which surround them, and which are everywhere, on approaching the granite, considerably altered; chiastolite, andalusite, garnet, mica and other minerals appearing in the slates, which are also occasionally changed to quartzose or felspathic mica schists, and the associated fossiliferous limestone to crystalline and micaceous dolomites with the fossils still perfectly distinct. It has been customary and orthodox to regard these granites as "intrusive," and they are so designated by Sir W. Logan. I hold that there is absolutely no proof of their being so, either in the Eastern Townships, in Nova Scotia, or in Intrusive granites.

* Geology of Canada, 1863, Chapter XVI.

Australia, and that all the phenomena connected with them may be more readily explained and understood if we regard them as completely metamorphosed portions of the strata which now surround them; while the mere displacement of strata involved in the intrusive theory appears, in view of the enormous areas now occupied by the granite, wholly inexplicable, as does also the manner in which the surrounding strata often dip down against and on to the granite, and show no signs of having been deflected or otherwise affected as regards strike and dip by the supposed intrusion.

There is, however, often seen along the contact lines of the granite and the slates a considerable breaking up and crushing of the latter, and this has been held to indicate, and be the result of the intrusion of the granite. It appears to me to be mainly due to the unequal resistance that the two rock masses have offered to the disturbing forces of upheaval, depression and consequent pressure which have repeatedly affected them long after the formation of the granite. The effect thus produced is analogous to that which occurs where the forces producing slaty cleavage encounter interstratified hard layers of sandstone, when the elsewhere perfectly regular and parallel cleavage planes are immediately crushed, crumpled and deflected.

In regions where the granite or other hard, crystalline rock is older than the adjacent or alternating softer strata, perfectly similar contact lines may be seen, but unaccompanied by any change in the mineralogical character of the adjacent strata, such as occurs when the crystalline rock is the youngest; and therefore this phenomenon cannot be taken as conclusive evidence of the intrusive origin of granite or other crystalline rock.

New Brunswick. Explorations of Messrs. Ells and Broad.

The work in New Brunswick was continued in the north-east in the counties of Northumberland, Gloucester and Restigouche by Mr. Ells, and south of the river St. John in the counties of York and Carleton by Mr. Broad, who also connected his work with that of Mr. Ells by a survey of the road, about 100 miles, from Fredericton to Newcastle. Altogether more than 400 miles of roads were surveyed during the season by odometer and chain; about 950 miles of the courses of the south-west Miramichi, the Nipisiguit, the Upsalquitch and the Restigouche Rivers and their tributaries, by canoe; and numerous traverses made through the woods to examine and define the limits of the several geological formations. Mr. Ells' explorations occupied from the 3rd May to the 25th November; expenses, $926.74. Mr. Broad's exploration occupied from the 3rd May to the 25th November; expenses, $517.94.

Mr. Ells' detailed report is submitted with this, see pages D. 1 to 47, but it is considered desirable to defer the publication of Mr.

Broad's report till the topographical survey of the region is further advanced.

Work in Nova Scotia by Mr. Fletcher.

In Nova Scotia, Cape Breton Island, the work of the survey under Mr. H. Fletcher comprised further explorations and measurements in the Richmond and Port Hood coal fields; also surveys of roads and brooks between Whycocomagh and Mabou River, and between Cheticamp and St. Ann's Harbor. The courses of the Margaree, Middle and St. Ann's Rivers were also surveyed. The gold mines of Middle River occur in a series of schistose rocks, which extends far to the northward, and is probably the source of the gold previously discovered by Mr. Campbell in the sands of the Cheticamp River, Jumping Brook, and other streams. The formation should therefore be carefully examined and its limits accurately defined and of even greater importance is the accurate determination of the lines of contact of the Carboniferous and the pre-Cambrian formations, as along these lines all the valuable deposits of iron and manganese ores occur, such as those recently discovered at Fork's Lake, on the flank of the Coxheath hills, and at the head of Loch Lomond. The season's explorations in Cape Breton occupied from the 4th May to the 25th December; expenses, $1,259.31. For detailed report of these investigations see pages F. 1 to 125.

Palæontological work.

The examination of the fossil plants of the Carboniferous rocks of Canada. in the collection of the survey, commenced in 1879, has been completed. The species not hitherto determined have been identified by Principal Dawson. The whole series is now properly named and labelled.

The following collections have been examined during the year:

1. A small series of fluviatile mollusca from the Lignite Tertiary, or "Fort Union Group" of the Souris River, Manitoba, collected by the Director.

2. About 90 specimens of fossils, or fragments of fossils, from the Palæozoic and presumably Devonian rocks of the Pine, Battle, Burnt and Elk Rivers, B. C., collected by Dr. G. M. Dawson, in 1879.

3. Rather more than 100 specimens of Cretaceous fossils from the Burnt, Battle, Pine and Smoky Rivers, and Coal Brook, B. C., also collected by Dr. G. M. Dawson, in 1879. Notes on the two last mentioned collections have been prepared and published in Dr. G. M. Dawson's report in this volume.

4. 79 specimens of Lower Silurian and Devonian fossils from the Red River, Manitoba, and the valleys of the Nelson and Churchill Rivers, collected by Dr. R. Bell, in 1879. A report on these fossils has been prepared by Mr. Whiteaves, and published as a supplement to Dr. Bell's account of his explorations on the Churchill and Nelson Rivers.

5. 50 specimens of fossil fishes, from the Devonian rocks of Scaumenac

Bay, Restigouche River, Baie des Chaleurs, collected by Messrs R. W. Ells and T. C. Weston, in 1880. A paper describing the species in these two collections has been published in the August number of the "American Journal of Science" for 1880.

During the months of July, August and part of September, Mr. A. H. Ford was engaged in an examination of the fish-bearing beds of Scaumenac Bay, P. Q. From this locality he has collected 282 specimens of fossil fishes, most of them of great interest, although the actual number of species is not very large. This collection has been subjected to a preliminary examination, and some notes on the specimens have been read at a meeting of the Natural History Society of Montreal, held on the 25th of October, 1880.

One hundred and fifty-five fossils from the Clinton and Niagara formations (Silurian), of Hamilton, Ontario, have been presented by Colonel Grant during the year.

Since the commencement of October, 1880, a considerable portion of the time of Messrs. Whiteaves and Ford has been occupied in labelling specimens, and in supervising the packing of fossils, and other preparations for the removal to Ottawa.

Work of Messrs. Weston and Willimot.

The work of Messrs. Weston and Willimot, in the Museum, has consisted largely in preparations for removal, including the packing and cataloguing the contents of upwards of 900 boxes and barrels, 326 of which were removed to Ottawa before the close of navigation in November, 1880.

Chemical branch.

The work in the laboratory of the Survey has included :—

1. Analyses of lignite or brown coal, from the N. W. Territory and British Columbia.

2. Analyses of iron, copper and manganese ores.

3. Analyses of graphitic rock.

4. Gold and silver assays.

5. Miscellaneous examinations, embracing the qualitative examination of a mineral water, the estimation of nickel and cobalt in pyrhotite from various localities, &c., &c.

In addition to the foregoing work many other miscellaneous examinations have been made of mineral specimens either sent to or left at the Museum for that purpose. A very appreciable amount of time has been devoted to visitors having minerals for identification, or desirous of acquiring information in regard to the economic importance of others. The details of the work are given in Mr. Hoffmann's report. See pages H. 1 to 21.

Library.

Twenty volumes have been added to the library by purchase, and 152 books, pamphlets and maps have been presented during the year, in return for the publications of the survey; 745 copies of which have

been distributed from the office of the Survey in Montreal, in addition to those distributed by the Interior Department from Ottawa.

1,183 names were registered in the visitors' book during the year, being 447 fewer than during the corresponding period in 1879. This falling off is probably due to the very general impression which has prevailed for some time, that the Museum was already removed to Ottawa. Visitors to the Museum.

The staff of the Survey as now classified under the Civil Service Act, consists of :—

1 Chief Officer,
4 First Class,
8 Senior Second Class,
5 Junior Second Class,
2 Third Class.

Mr. James Richardson and Mr. Robert Barlow have retired under the superannuation provisions of the Civil Service Act.

The Annual Report for 1878-79 was issued early in 1880, in a volume of 375 pages, 8vo., with 29 illustrations and eight geological and topographical maps. It is, as usual, published in English and French. The English edition, 3,500 copies, cost $1.15 per copy; and the French edition, 500 copies, cost $3.90 per copy. Annual Reports.

In connection with the foregoing the Director desires to call attention to the fact that while the cost of publishing the results of the labor of the Geological Corps, and likewise the salaries of the Staff are annually increasing, no corresponding increase has yet been made in the annual appropriation for the work, which has continued for the past four years at the sum of $50,000, which, to carry on explorations extending from the Atlantic to the Pacific, to support a Museum, Laboratory and Library, and to publish the results of the work accomplished, in two languages, is, it is submitted, wholly insufficient, and must be accepted as an excuse for many of the imperfections and shortcomings of the published work.

MONTREAL, 1st May, 1881.

REPORT

BY

ALFRED R. C. SELWYN, LL.D., F.R.S.,

DIRECTOR OF THE GEOLOGICAL AND NATURAL HISTORY SURVEYS OF CANADA.

ON BORING OPERATIONS IN THE

SOURIS RIVER VALLEY.

1880.

Leaving Montreal on the 13th of May, I reached Winnipeg on the 18th at 12.30 a.m. The following four days were employed in procuring the necessary outfit, horses, carts, &c., and engaging men. Left Winnipeg at noon on the 23rd by steamer for West Lynne, arriving there early the following morning. Here we found the contractors, Messrs. McGarvey & Highman, and their party encamped. They were endeavoring to engage teams to transport engine and boring plant, &c., to the proposed site of operations near Roche Percée, in the Souris River valley. I left West Lynne the same day, and proceeded westward partly by the old Missouri, and partly by the Boundary Commission trail. Bad roads and high water in the creeks and rivers caused considerable delay, especially at the two crossings of the Souris River, where neither boat nor raft was found, nor available timber to construct one. The crossings were, however, accomplished without accident, and on the 17th of June we reached the Riviere des Lacs, 229 miles west from the Red River. This curious sheet of water is described by Dr. G. M. Dawson* as follows:—

"The so-called *Rivière des Lacs*, which crosses the Line at the 227 mile point, seems to occupy the bed of a former stream. This sheet of water where it is intersected by the Line, must be nearly three-quarters of a mile wide, and is not fordable. It occupies the bottom of Rivière des Lacs.

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* Report on the Geology and Resources of the Forty-ninth Parallel, 1875.

a valley, and is over fifty feet below the prairie level. Northward it extends about four miles, becoming gradually narrower, and ending in a broad coulée, which shallows and dies away in a strip of boulder-covered ground, which stretches northwestward toward the Souris River five miles distant, and is somewhat lower than the general surface of the plain. Southward it is said to extend about seventy miles, and finally to join the southern bend of the Souris River, where it gives issue to a small running stream."

Fixing sites for bore-holes.

The examination for fixing the sites of the proposed borings commenced at this point. The afternoon of the 17th was spent examining the banks of the Riviere des Lacs, and the prominent hill which rises at its upper end. This Hill is unnamed on the maps, but is known by the traders and half-breeds as the Hill of the Murdered Scout. Though only about 100 feet above the general level of the plain it is, especially from the eastward, a conspicuous object, and affords from its summit a very extended view over the surrounding country. On the 18th an examination was made in a southerly direction from Rivière des Lacs to the Souris River, and for several miles up the valley of the latter, including a number of the adjacent dry coulées. Over considerable areas the surface presents a bed of closely-packed ice-borne boulders of Laurentian rocks, and fossiliferous Silurian white or cream colored limestone, some of the latter being of gigantic size. Three of these boulders gave the following dimensions: 6 x 13 x 14 feet; 4 x 11 x 11 feet, and 6 x 5 x 3, The largest would contain 1092 cubic feet and weigh more than 85 tons. These all lay within an half mile radius. There were many others in the vicinity presenting flat surfaces of nine feet by six feet, the thickness of which was not ascertained, as they were more or less imbedded in the soil.

Large limestone boulders.

The dry coulées, which are one of the most remarkable features of this part of the Souris River valley, nearly all have courses more or less parallel with that of the main valley, and appear to be the ancient flood channels of the Souris when its main channel was at a much higher level. The intervening ridges must then have formed long boulder-covered reefs or islands in a broad river. These peculiar coulées or side valleys were not observed on the right bank of the river west of St. Peter's spring, or on the left bank west of Roche Percée. They appear to be limited to about two miles on either side, and to extend from the vicinity of Roche Percée eastward to where the river makes its great northern bend. In some instances they open into the main valley, gradually rising till they run out on the level of the plain 100 or 150 feet above the river. While the tops and sides of the intervening ridges are a mass of boulders, the bottoms of the coulées are comparatively free, and are often occupied by water-holes

Topographical features of the country.

and grassy swamps, in which ducks and other wild fowl abound, and along the margins of which wheeled vehicles can pass from the river valley to the plain.

As the whole of the country traversed on this occasion has been fully described by Dr. Dawson in the volume already referred to, it is proposed to confine those remarks chiefly to a brief statement of the work in connection with the boring operations, which, unfortunately, the limit of the funds available prevented from being carried to a satisfactory conclusion, a sufficient depth not having been reached to decide the question for which the work was undertaken when it had to be suspended.

No outcrops of the lignite formation could be found in the country around the Rivière des Lacs, nor any evidence of the probable thickness of the drift. I therefore on the 21st June proceeded westward 24 miles and camped at Roche Percée to await the arrival of the boring party, of whom no tidings had been received since leaving the Pembina River on the 1st of June.

On the following morning, 22nd June, one of the contractors arrived at Roche Percée, and reported that the teamsters had refused to bring the engine, &c. beyond the second crossing of the Souris, and had left them to return east. This obliged the contractors to bring the boring plant on by instalments, with their own four horses and two wagons. In the meantime the men were employed getting out the timber required for derrick, engine-bed, &c., much hunting up and down the river being required before suitable trees could be found. The next few days till the 30th June we remained encamped at Roche Percée, the time being occupied in making a careful examination of the valleys of the Souris River and of Short Creek, also of the adjacent country southward to the International Boundary. The site for the first bore was fixed, photographs taken, and a section measured from the left bank of the Souris south to where the east bank of Short Creek intersects the Line, a distance of about four and a half miles. On the 30th June we moved camp six miles down the river, close to the site selected for the first bore hole. The next nine days were occupied in further examinations of the small valleys on either side of the river, searching for outcrops of the lignite, in making a plan of the neighborhood of the bore, and in collecting fossils.

Preparations for boring.

It now became necessary to consider the best site for the second boring. Immediately opposite this camp the sandstone with associated lignites appeared to pass beneath the plain. These being the most easterly visible outcrops in the Souris Valley, it was hoped the same strata might be again found cropping out in the valley of Moose Mountain Creek, where it meets the apex of the great northern bend of the Souris, some twenty

miles distant to the north-east, and thus demonstrate the extension of the lignite-bearing formation in this direction. On the 10th of July I proceeded across the plain to Moose Mountain Creek, and struck it at about one and a half miles above its confluence with the Souris. It lies here about 130 feet below the level of the plain, and has a shallow, stony bed with deep pools one quarter to half a mile in length, connected by rapids. Some of the hills have a very steep slope to the creek, but show nothing but gravel and brown silt and clay mixed with boulders. Up some of the side gullies, which are also steep and narrow, rising rapidly to the plain, there are patches of willow and brush indicating moisture, which may be at the bottom of the drift, or only at the outcrop of impermeable beds of clay associated with it. Surface evidence by which the choice of a site for the boring could be determined being wanting, it was decided to fix it on the plain at a point about two miles west of the confluence of the creek and river.

Moose Mountain Creek.

Returning to the site of No. 1 bore on the 12th, we found the work had commenced that afternoon. The details of the boring are given on pages 8 to 11, A.

District examined.

The examination made extended south to the Line, and west to the Wood End depot, and embraced all the principal northern side gullies. These are for the most part short, running steeply up to the plain, which stretches northward as an almost unbroken treeless expanse for more than fifty miles towards the valley of the Qu'Appelle River. The greater part of the area indicated, west of No. 1 bore, and south of the Souris River, except where affected by the denudation of the valleys, may be regarded as a coal-field. There is no evidence to show the extent of the field to the north of the river. It is probably large, but there can be no doubt that the area to the south of it is underlaid by the same seams that are well exposed in the bank of Short Creek, immediately above its confluence with the Souris, and which are also seen at intervals both east and west along the main valley, and in many of the smaller gullies that descend from the plain on either side.

In many places the outcropping edges of the lignite seams are either burnt, and now only indicated by lines of red shale, or they are concealed by land slides, making it exceedingly difficult to connect such outcrops as are still well exposed. Sufficient of these, however, are seen to prove that at least two workable seams occur over an area north of the 49th Parallel, in the Souris Valley, east and west of Roche Percée, which may be safely estimated at about 120 square miles.

Section at the Sutherland Mine.

The section of the strata exposed at the junction of Short Creek and the Souris River measures 145 feet on the angle of the cliff, and is as

follows, in descending sequence. The cliff slopes at 75° to 80°, and is in some parts vertical:—

		Feet	in.
1.	Soil and superficial drift	5—6	0
2.	Sand rock, or sandy clay	10	0
3.	*Lignite*	2	0
4.	Clay shales, dark drab plastic	1	6
5.	*Lignite*	5	0
6.	Whitish soft sand rock	50	0
7.	*Lignite*	3	0
8.	Soft brown sandstone	17	0
9.	Ironstone, nodular and lenticular.......... 6 to	7	0
10.	Whitey brown sand rock, with bands and concretions of ironstone	49	6
		145	0

The bands and layers of ironstone here contain fine specimens of fossil leaves, a large collection of which was made. Principal Dawson has kindly examined these, and furnished the notes appended. The specimens are now exhibited in the Geological Museum, Ottawa.

In the 5 feet seam, a level 78 feet in length and 3 feet wide, has been driven by W. D. Sutherland, of Winnipeg, and in the spring of 1880 several tons of the lignite taken out were floated in barges down the Souris and Assiniboine Rivers to Winnipeg, and a large heap still remained on the bank at the time of our visit. On the surface it had all crumbled by the action of the weather, but on digging into the heap large sized solid blocks were found.

In the tunnel the lignite appeared to be solid, and of good quality. The upper seam is only between 15 and 20 feet below the prairie level, and thus slight depressions in the surface would suffice to have caused its removal.

In the foregoing section Nos. 2 to 5 are clearly the same beds, as Nos. 8 to 11 in Dr. Dawson's section No. 7, which was measured by him in 1873, not a mile distant, on the opposite side of Short Creek (See page 17 A, Appendix II.) East of the Sutherland mine section, and extending for a distance of about seven miles along the valley to the site of No. 1 Bore, there are numerous sections on both sides of the river in which the same seams of lignite are exposed. The most perfect section occurs on the south side, near the mouth of a gully which takes its rise on the plain, below and a little west of St. Peter's spring, and is probably the channel by which its waters reach the Souris River.

Comparison of the sections.

St. Peter's Gully section.

St. Peter's Gully Section.

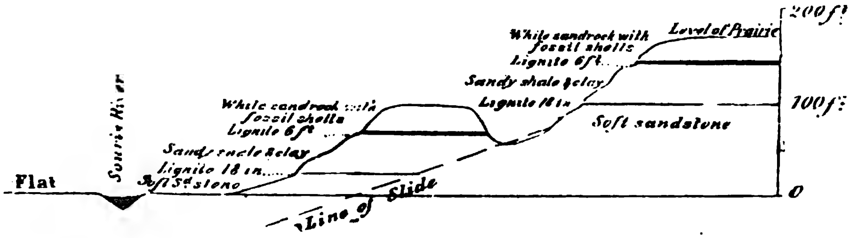
		Feet	in.
1.	Soil and sandy clay	10	6
2.	*Lignite* 2ft. 6 in.—	3	0
3.	Soft drab sand rock	9	0
4.	Ironstone band	0	8
5.	Soft drab sand rock	8	4
6.	*Lignite*	0	8
7.	Sandy clay shale	8	0
8.	Ironstone with clay shale 1 foot to	1	6
9.	Sandy shale	8	4
10.	Do. with carbonaceous streaks	2	0
11.	Sandstone and concretionary sand rock	0	0
	with ferruginous bands and concretions	9	0
12.	Clay shales	5	0
13.	Carbonaceous streak	0	6
14.	Clay shales, sandy	5	0
15.	Ironstone and shale	2	0
16.	*Lignite* (underlaid by stiff clay shale)	3	0
		76	6

In the above section No. 16 is probably the equivalent of No. 7 in the Sutherland mine section, and No. 2 represents No. 5, notwithstanding that the intervening measures differ considerably in character, and about ten feet in thickness.

Short Creek. To the south, a few yards north of where the Boundary Line crosses the east branch of Short Creek, a seam is exposed in the bank sever feet thick, with a shaly parting of three inches, at about two feet from the top. It is not more than fifteen feet beneath the surface of the plain, and the drift covering is thin. Eight or ten feet below the seam is the water level of the creek. On the north side of the river, and a little above the St. Peter's gully section, a very interesting exposure occurs, in which the whole cliff has slid down into the valley. At 25 feet below the prairie level, which is here about 140 feet above the river, the six feet seam crops out, and is well exposed, resting on 30 feet of clay shales and sand rock, underlaid by lignite eighteen inches thick. Below this the ground is broken, and the measures concealed in a depression. On passing across this and over the rise there is a cliff about 40 feet in height, rising abruptly from the river flat, in which both seams are again exposed. The six feet seam can be seen here for nearly 200 feet in length, beyond which on either side it appears to have been completely burnt away, the position of it being indicated by irregular

heaps of hardened red shale, the whole surroundings being not unlike those of an old brick yard.

A section across this ground from the prairie level to the river is represented in the figure below:—



The lower 3 feet seam seen on the opposite side of the river in the St. Peter's Gully section was not observed here, its outcrop being probably concealed by the slides.

It may be assumed that there are in this region, above the level of the Souris River, at least eight feet of available lignite coal over an area of not less than 120 square miles. This would give 7,136,864 tons to the square mile, calculating the cubic foot at only 64 lbs. Quantity of lignite per square mile.

From the vicinity of St. Peter's spring eastward there appears to be a gradual fall in the country amounting to about 2½ or 3 feet per mile. The strata are apparently horizontal, but probably have a slight westerly dip which, together with the fall in the ground, would cause them to crop out rapidly beneath the drift-covered plain to the east, and perhaps explains their not being found in the bore-holes at Moose Mt. and South Antler Creeks, the details of which are given on pages 8–9 A. The same cause does not, however, affect the Turtle Mountain bore-hole, as the country there again rises to an elevation, on the Line, six miles to the south, of 2,000 feet, and from the evidence afforded by the creek, which runs through Sections 32, 33 and 34, Township 2, Range 19, West, it seems that, though no lignite was struck in the bore-hole situated six miles to the south, the country here is nevertheless underlaid by the sandstones, clays, and ironstone of the lignite Tertiary formation, and therefore an available seam of lignite may at any time be discovered.

The details of the Turtle Mountain bore-hole are given on page 10 A.

No. 1.

SOURIS RIVER BORE.

IN THE VALLEY OF THE SOURIS, $6\frac{1}{4}$ MILES BELOW ROCHE PERCÉE.

295 *feet deep;* 1610 *feet above sea level.*

The work here was commenced on the 8th of July, by sinking a pit about ten feet deep, showing :—

Soil	3 ft. 0 in.
Stiff grey clay, like clay below lignite	6 " 6 "

No. 1 bore-hole. On the 12th of July the boring commenced, and reached a depth of seventeen feet, all in stiff, dark clay. At eighteen feet the rock, a soft, friable, brown sandstone which crops out at the river immediately below the bore-hole, and about 77 yards distant, was struck, and continued almost without change to 154 feet, where it rested on a very tenacious blue clay. At 68 feet some small fragments of lignite came up in the sand pump, and from 48 to 73 feet fragments of ironstone and lignite in powder.

On the 15th the water which up to that time had stood in the hole at about five and a half feet from the surface, suddenly sank to within 38 feet from the bottom, and shortly after the rods dropped one foot. This occurred between the 68th and 73rd foot. On the 22nd, when a depth of 273 feet had been reached without change, through 119 feet of clay, a seam of lignite was struck, and the next 23 feet gave a section as under :—

Lignite	6 ft.	1 in.
Clay	1	0
Soft sandstone	1	0
Clay, same as above lignite	15	0

making a total depth of 295 feet from the surface, or about 575 feet below the plain at St. Peter's spring.

No. 2.

MOOSE MOUNTAIN CREEK BORE.

$20\frac{3}{4}$ MILES FROM No. 1.

155 *feet deep*; 1590 *feet above sea level.*

No. 2 bore-hole. This bore was situated on the level of the plain, about 128 feet above the river, $2\frac{1}{8}$ miles west 10° south from the confluence of Moose Moun-

tain Creek and the Souris River; and 20¾ miles distant in a direct line from Bore No. 1.

Boring was commenced here on the 7th August, with a ten-inch auger, from the surface, giving the following section:

	Feet	in.
1. Black loam	1	6
2. Yellow brown sandy loam	3	0
3. Gravel	2	0
4. Stiff sandy clay	8	6
5. Stiff dark blue clay	5	0
6. Quicksand		9
7. Stiff dark blue clay	10	3
8. Gravel, same as 3, but coarser		9
9. Dark blue clay	23	3
10. Cemented gravel, passing down into soft gravel	2	0
11. Loose gravel, mixed with some dark grey clay	4	0
12. Clay mixed with fine gravel and boulders	79	0
13. Dark grey clay	15	0
	155	0

On the 16th August, in a depth of 18 feet, five boulders were passed, supposed to be granite. At 83 feet a small sample of lignite was brought up, apparently a drifted fragment.

From the foregoing record, and from a careful examination of the samples, it would seem that the lignite-bearing Tertiary formation was not reached in this boring, only the superficial deposits and boulder drift having been penetrated.

No. 3.

SOUTH ANTLER CREEK BORE.

37 Miles from No. 2.

155 *feet deep;* 1595 *feet above sea level.*

This boring was made at a spot 700 yards east of where the Boundary Commission trail crosses the North Antler Creek. The elevation here, according to the Boundary Survey, is about 1645 feet. The site of the bore would be about 50 feet below this, or 1595 feet, nearly the same elevation as the Moose Mountain Creek bore. This bore, like No. 2, did not penetrate the drift, which consisted of sand, clay and gravel, No. 3 bore-hole.

with some boulders, chiefly made up of the white or cream colored Palæozoic limestone.

The boring commenced here on the 1st of September, and finished on the 5th, giving the following section:—

	Feet	in.
Dry sand and gravel	3	0
Yellow sandy clay	7	0
Dark blue clay, mixed with fine gravel	15	0
Limestone boulder		
Clay and gravel mixed	2	0
Boulder drilled through	2	0
Grey clay and sandy clay	39	0
Sandy clay and gravel	6	0
Sand, with sandy clay and gravel	9	0
Fine dry sandy clay and sand, with small pieces of white limestone (silt)	20	0
Do., with water coming in slowly	19	0
Do., with clay, passing into the next	18	0
Sand	15	0
	155	0

The absence of water in this bore till a depth of 122 feet was reached is singular. When the work ended the water stood at 95 feet from the surface. Owing to the constant falling in of the sides of the holes, it is impossible from the samples brought up to give a very accurate description of the different strata bored through.

NO 4.

TURTLE MOUNTAIN BORE.

63 Miles East of No. 3. 200 Feet Deep.

No. 4 bore-hole. This bore was made in the south-east corner of Section 6, Township 1, Range 19, West. Commenced on the 20th September, and finished on the 6th October.

No lignite was met with, and as in the case of the other bores, and from the same cause, there is considerable uncertainty as to whether the Tertiary lignite-bearing formation was reached.

At 43 feet, and again at 103 feet, beds of well-rounded gravel were found, but from about 160 to 200 feet, nothing but dark blue or grey clay was met with, which cannot be distinguished from that

passed through both above and below the lignite seam in No. 1 bore.

The elevation of the country at this point is nearly the same as at St. Peter's spring, viz., about 1,900 feet, and inasmuch as the beds are, as already stated, nearly, if not quite horizontal, it was considered not unlikely that they might be found here, even if absent in the intervening lower country. After the boring had commenced it was found that sandstones similar to those associated with the lignite seams of Roche Percée cropped out in ledges for a considerable distance along the creek which traverses the north part of Sections 33 and 34, Township 2, Range 19 West, and are accompanied by ironstone and the peculiar red (burnt) shales, indicative of the combustion of lignite seams. The relative level of this locality and the No. 4 bore hole is not known exactly. It is presumably considerably lower, and it is quite probable that seams of lignite occur here, which might have been discovered had there been funds available to continue the boring to greater depth.

APPENDIX I.

ON THE

LIGNITE TERTIARY FORMATION

FROM THE SOURIS RIVER TO THE 108TH MERIDIAN,

BY

GEORGE M. DAWSON, D.S., A.R.S.M., F.G.S.

[NOTE.—The introductory pages of the subjoined account of the Tertiary Lignite Group of a portion of the North-West Territory, are based on an article on "The Lignite Formations of the West," (*Canadian Naturalist*, Vol. vii., No. 5). The descriptions of localities and analyses of lignites and ironstones is reprinted, with little alteration, from the "Report on the Geology and Resources of the 49th Parallel," published in connection with the Boundary Commission Expedition. The name *Lignite Tertiary* having been used in the report above referred to, is here retained for this northern extension of the Fort Union Group.]

Carboniferous system in the West, poor in coal.

The true Carboniferous system with which the greater part of the valuable coals of the world are associated, and which is so largely developed in the eastern half of the American continent, from Nova Scotia southward, is not the coal-bearing formation of the western prairie region. Rocks of Carboniferous age are, it is true, found in the eastern part of Nebraska and in Iowa, where the thickly-wooded country of the East has already passed into the prairie land of the West. Here, however, the formation depended on for fuel in so many parts of the world has to a great extent lost its coal-bearing character, and where it is last seen in Nebraska, though now pretty thoroughly explored, both by surface examination and boring, has yielded coal in very sparing quantity. This region, in fact, appears to be upon the western lip or margin of the true coal formation, and the sandstones and mud rocks usually associated with coals are being replaced by limestones, indicating deeper waters and the absence of the terrestrial conditions necessary to the growth of the coal-producing plants.

Poor as these western Carboniferous rocks are in coal, they labour under the additional disadvantage of being in great part covered by a newer formation, the Cretaceous; and where the Carboniferous system again comes to the surface in the Rocky Mountain region of uplift, to the west of the Great Plains, it has not been found to contain so much as a single seam of coal, but it is represented chiefly by massive limestones, implying deposit in deep ocean water, and so far removed from land that it is rare to find in them even a fragment of any of the plants which were growing so luxuriantly in the swamps and deltas of the eastern half of the continent at the same time. Just where the coal of Palæozoic age fails, the luxuriant forest growth of the East also comes to an end, and the country assumes that prairie character which, to the south of the Saskatchewan, persists with scarcely a break to the foot-hills of the Rocky Mountains. The bare rolling plains and grassy hills, through over extensive areas eminently suited for agriculture, seldom yield wood in sufficient quantity to ensure a permanent supply of fuel. Trees in the true plain country are found only fringing the deep river valleys and in steep-edged gullies, where they are protected from the sweep of the prairie fires, and find a permanent suply of moisture. Treeless country.

In the eastern portion of our North-west Territory, including Manitoba, the Carboniferous system is not found at all, but the Cretaceous rocks already alluded to overlap the limestones of the older Silurian and Devonian periods. The true coal formation can, therefore, in this region, only be supposed to exist below a great thickness of Cretaceous rocks, and even if accessible, the probability of coal of any value being found in it is—from analogy with the portion of the Western States already mentioned—exceedingly small. No Palæozoic coals in the North-West.

Neither do the Cretaceous rocks (including under that name the beds to the top of Division No. 5 of Meek and Hayden's section) of the eastern portion of the plains yield, so far as known, any fuel of economic value, in their great stretch from the borders of Mexico to the northern part of the North-west Territory. They consist almost entirely of clay rocks and sandstones, with one interesting zone of limestone and marl, which forms part of the Niobrara Division, or No. 3 of the classification above referred to, and which appears to be recognizable in Pembina Mountain and the highlands west of the great lakes of Manitoba. Eastern Cretaceous rocks without coal.

The lower part of the Cretaceous system, however, in Nebraska and elsewhere on the Missouri River, seems to show an attempt at the production of beds of fuel. Beds of "impure lignite" and "carbonaceous clays" of small thickness are there met with, especially in Hayden's lowest or Dakota Group. Fossil leaves and stems are also Unimportant deposits of lignite only.

found associated with these beds, and I find one lignite mentioned as occurring in beds believed to be transitional between the Dakota Group and the Benton Group, immediately above it, which is even stated to have been worked to a small extent.

Small and irregular seams of lignite have also been found in western Minnesota in outliers of beds supposed to be of lower Cretaceous age, and it is probably from local deposits of this nature that the pieces of lignite sometimes found in the superficial drift deposits of Minnesota and Manitoba are derived. While there is, therefore, a *possibility* of the occurrence of fuels of some economic importance in the lower Cretaceous of Manitoba, such an event is by no means probable. The outcrop of these lower beds is, however, everywhere concealed by drift deposits and the alluvium of the Red River Valley, and they could be examined only by boring. In the western portion of the plains, in the vicinity of the Rocky Mountains, lignites and coals are now known to occur at several different stages in the Cretaceous rocks, but the series is there different lithologically, and the actual distance between the outcrops of the beds and those of the vicinity of the Red River, here referred to, is so great as probably to imply quite different conditions of deposition. Overlying the Cretaceous proper, however, are the representatives of the Fort Union beds of the United States geologists, and in these the extensive and numerous beds of lignite of the Souris River region occur, and constitute the nearest available source of supply of mineral fuel, so far as known, for the province of Manitoba.

Possible occurrence of lignites in Manitoba.

Lignites and coals in western Cretaceous.

Lignites of the Fort Union Group.

Cretaceous and Tertiary groups on the Missouri.

The character and thickness of the different members of the Cretaceous in the Manitoba region have not been worked out in detail, owing to the extent of the drift covering and scarcity of sections. The following tabular arrangement of the sub-divisions on the Missouri, according to Meek and Hayden, probably represents the Manitoba regions also, with some approach to accuracy. An examination of it will render the relations of the Fort Union or "Lignite Tertiary" beds quite clear.

	Feet.
Fort Union Group.—("Lignite Tertiary.")—Hard and soft sandstones, clays and shales, with lignite coal	2,000*
No. 5.—*Fox Hill Group.*—Grey, ferruginous and yellowish sandstones and arenaceous clays	500
No. 4.—*Fort Pierre Group.*—Dark grey and bluish shales or clays	700
No. 3.—*Niobrara Group.*—Calcareous marls	200
No. 2.—*Fort Benton Group.*—Dark grey laminated clays or shales, with some limestone	800
No. 1.—*Dakota Group.*—Yellowish, reddish and whitish sandstones and clays	400
	4,600

* Or more.

In the flat country of the Red River Valley, no exposures of the Cretaceous rocks are found, and it is below the alluvium of this region that the older sub-divisions probably occur. The western margin of the valley is formed by the escarpment of the second prairie steppe, and here, in the so-called Pembina Mountain, and in its continuation to the north-westward, the Cretaceous beds are first met with. About twenty-five miles north of the forty-ninth parallel, where the Boyne River cuts through the Pembina escarpment, beds clearly referable to the Niobrara Group are known to occur, and precisely resemble both lithologically, and in their included fossils those of the corresponding Nebraska division. The rock is generally a cream-coloured limestone, chiefly composed of shells of *Inoceramus* and *Ostrea congesta*, but in places a white, chalky material, which under the microscope is resolved into a mass of foraminiferal shells, coccoliths, and allied minute organisms. This exposure, though probably small in extent, enables the outcrop of the Niobrara to be defined at a point nearly four hundred miles beyond the furthest northern locality known previous to its discovery. Still further north, along the outcrop of the Cretaceous, at Swan River and Thunder Hill, west of Lake Winnipegosis, limestones and marls containing fossils like those of the last-mentioned locality, and evidently of Niobrara age, are again found, and other outcrops of these, and possibly of older beds, may probably be discovered in this vicinity. Niobrara Group in Manitoba.

With these exceptions, however, the Cretaceous rocks known to occur between the Red River Valley and the Lignite Group of the Souris region belong exclusively to the Pierre Group of the Cretaceous, while the Fox Hill Group, which should intervene between this and the lignite-bearing series, has not in this district been recognized, and is, not improbably, but feebly developed.

The Pierre rocks found in occasional exposures in this district resemble those described in the table above quoted, consisting of dark-colored greyish, bluish or blackish shales, generally homogeneous in character through great thicknesses, and seldom containing fossils of any kind, though frequently charged with selenite crystals and holding nodular layers of poor ironstone. Exposures of these beds are found in the Pembina escarpment, on the Pembina River and its tributaries, and on the Assiniboine, where the thick drift deposits have been cut through. The clays or shales are generally quite characteristic in appearance, and where they are found it may be taken for granted that the lignite-bearing formation has either been removed by denudation or has from the first been wanting. Though usually in appearance quite horizontal, these beds must have a general light westerly dip, which carries them beneath the lignite group of the Souris River. Pierre Group.

In the vicinity of the forty-ninth parallel, the furthest western observed exposures of these Pierre shales occur on Cypress Creek,* about forty miles from the base of the Pembina escarpment. From this point for about 150 miles, the country is so thickly covered by drift deposits that none of the streams cut through to the underlying strata, or if the great valley of the Souris does so, the rocks are concealed by its gently sloping and grassy banks. When the rocks underlying the drift are again seen, near the Roche Percée, they belong to the overlying lignite-bearing series.

Drift-covered country.

North-east edge of Lignite Tertiary.

In my preliminary report on the Lignite Tertiary† it was stated that the north-eastern edge of the Lignite Tertiary formation, probably crossed the Souris about five miles east of the Roche Percée, and was connected with a gentle rise which runs south-eastward across the plains from this point. In 1874, however, a thin seam of lignite was found in clays below the Roche Percée, and on the map accompanying the *Geology and Resources of the 49th Parallel*, the boundary was marked so as to include these furthest east exposures. As stated in Dr. Selwyn's report, however, the result of the late borings has been to show a great depth of rocks of the lignite-bearing series below those seen furthest down the Souris in natural exposures, and the line representing the edge of the formation must, therefore, be moved still further north-eastward, though to an undetermined distance.

North-eastward from its intersection of the Souris, the line indicating the margin of the formation, as shown on the map just referred to, is not founded on direct observation, the country being heavily drift-covered, but is drawn with reference to all known exposures of the rocks—joining with Dr. Bell's observations northward—and is probably not in any part of its course very far from the truth.

Portion of the Souris, showing outcrops.

From the point where the Lignite Tertiary beds are first seen in the valley of the Souris, at a point 250 miles west of the Red River, and about six miles east of the tributary from the south known as Short Creek, exposures occur at frequent intervals in the banks of the Souris Valley, westward, to the position occupied in the summer of 1873 by Wood End Depot Camp, a distance of about twelve miles from east to west and considerably more by the river.

Lowest beds seen.

The hard sandstones of the Roche Percée series fringe the Souris Valley, near the mouth of Short Creek, and give it a picturesque appearance. These are not, however, the very lowest visible beds of the formation, as some miles east of this point, and underlying the sandstones, whitish and purplish clays, and arenaceous clays occur; and in

* Called Long River in my reports in connection with the Boundary Commission Expedition.
† Report on the Tertiary Lignite Formation in the vicinity of the Forty-ninth Parallel. North American Boundary Commission, 1874, p. 12.

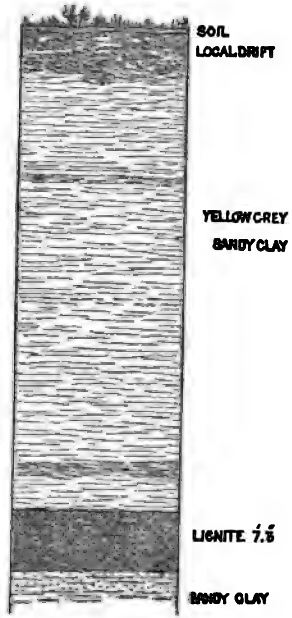


Figure 1—Souris River.

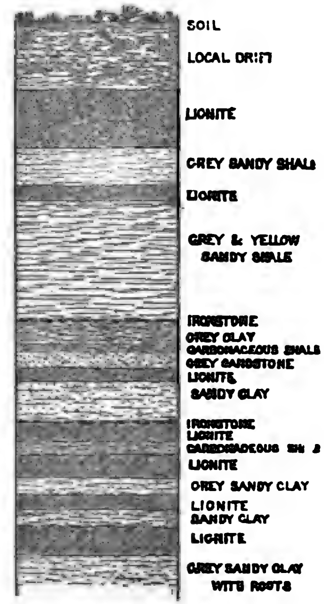


Figure 2—Souris River.

one place, as above stated, a small bed of lignite was found, with specimens of *Viviparus Leai* in the associated strata.

On the south side of the Souris Valley, and a short distance to the east of the valley of Short Creek, the Roche Percée group of rocks is situated. This locality has already been described by Dr. Hector, who made a branch expedition to it from the north, in August, 1857, being induced to do so by the reports of Indians and half-breeds.* These remarkable rocks, which have long been objects of superstition to the Indians inhabiting the surrounding country, owe their curious forms to the weathering away of a soft, grey sandstone from below a bed of similar rock which weathers yellow, and is rendered durable by an abundant calcareous cement. Both the upper and lower sandstones show false-bedded structure in great perfection; though that in the upper hard portion is on a smaller scale, owing to the thinner divisional planes of the rock. The capping sandstone is not hardened in a perfectly uniform manner, but in belts several yards in width, lying parallel in a north-west and south-east direction, and separated by spaces more easy of disintegration. There is also a system of cross-jointing nearly at right angles to this main direction. **Roche Percée sandstones.**

This combination of structures has given rise, under the long continued action of the weather, to the remarkably castellated, fantastic and picturesque rock scenery of this part of the Souris Valley. The hard belts form tongues projecting diagonally from the grass-covered bank, and the erosion of the underlying soft sandstone, parallel to the cross joints, has, in several places, produced window-like openings through them. The soft rock bears in many places rude Indian carvings, representing various animals and birds, strings of beads, &c.

Short Creek, already mentioned as an affluent from the south, shows many sections of the lignite strata. The banks of the stream have assumed the most picturesque forms from successive landslips, and are often quite red in colour from the alteration of the clays by the burning of lignites. One of the most perfect sections is on the left bank, near the crossing place of the Commission Trail, and extends from the level of the prairie almost to the water of the stream. (Plate II. A., Fig. 2.) **Short Creek.**

Section 7.* **Section at Short Creek.**

	Feet	in.
1. Soil	1	6
2. Yellowish coherent sand, grey externally, and holding some much broken *Unio*-like shells at its base.	12	6
3. Grey clay	2	10

* Exploration of British North America, pp. 49 and 225.
* The sections are numbered here as they appeared in the first report on the lignite deposits above referred to. The same numbers are attached to the analysis on a succeeding page.

	Feet	in.
4. Yellowish and greyish thin-bedded sands and sandy clays, with several very thin ironstone layers, weathering orange-red externally	6	0
5. Grey clay	2	4
6. Similar to No. 4, with decayed fragments of gasteropodus shells	12	0
7. Also similar to No. 4, but with a great number of thin ironstone sheets	3	0
8. Hard yellowish sandy clay, a few inches at the top carbonaceous	10	0
9. Good hard lignite	2	2
10. Hard yellowish sandy clay	2	7
11. Good lignite	4	9
12. Greyish sand and sandy clay, showing lines of stratification—in some places soft and incoherent, in others with large concretions, and sometimes forming a nearly solid sandstone	9	0
13. Hard grey clay	2	0
14. Greyish-yellow clay, with many thin layers of orange-weathering ironstone	3	0
15. Lignite	2	6
16. Greyish and yellowish hard sand and sandy clay	11	0
Section concealed by slope of detritus to water level, about	12	0
	99	2

Small spherical ferruginous nodules, resembling bullets, occur in considerable number at the foot of the bank. They have a calcareous cement, and are derived from one or other of the sandy layers. This exposure is remarkable for the very gradual passage of one bed into the next, making it almost impossible to draw lines between them in a measured section.

Souris Valley west of Short Creek.

Sections more or less perfect are exhibited in many places in the Souris Valley, a mile or two west of the entrance into it, from the south, of Short Creek, but more especially on the north side of the valley. They show a great similarity, though not absolutely the same in any two places. One of the most perfect exposures seen (Section 6) was in the face of a bank from sixty to seventy feet high, and consists of sand, sandy clays, and hard, fine clays, very regularly and perfectly stratified, and coloured in various shades of yellow-grey, grey and light drab. At two different levels harder sandstone layers of small thickness were seen, and also three distinct beds of lignite. The lowest is a hard compact lignite, resembling cannel coal in aspect, and two feet three inches thick. A few feet above this a second seam, eighteen inches thick, occurs; and still higher in the series, and about half-way up the

bank, a third, of the same thickness. At the top of the bank, some large nearly spherical sandstone nodules rest, and have evidently been derived from a superior bed which has been removed by denudation. The clays and arenaceous clays at several different levels include remains of mollusca, but these are very fragmentary, having been crushed by the compression of the containing material. A species of *Unio* is abundant, and remains of gasteropoda also occur, though rarely, and in poor preservation.

On the opposite side of the Souris Valley—which is here of considerable width—and not far from the last-mentioned section, soft sandstone beds capped by a harder layer of sandstone, weather into table-like forms. These beds are doubtless the representatives of those which a few miles eastward produce the Roche Percée.

Six miles north from the former position of Wood End Depot, at the bend of the river where Rough Bark Creek enters, the following section occurs:—

Section on Souris at mouth of Rough Bark Creek.

Section 1.

	Feet	in.
1. Fallen bank, no section, (about)	8	0
2. Finely stratified, greyish sandy clay	7	0
3. Lignite	0	7
4. Sandy clay, greyish, laminated, including two "leaf-beds," each a few inches thick	7	7
5. Yellowish fine sandy clay, passing below to grey soft sandstone	11	5
6. Ironstone, a nodular layer	0	3
7. Greyclay	1	0
8. Whitish clay	1	0
9. Carbonaceous shale	3	3
10. Grey clay	3	6
11. Ironstone	0	2
	43	9

The beds appear to be perfectly horizontal. Those of sand and arenaceous clay, though having the appearance of well characterized layers at a little distance, and giving the banks a ribboned aspect, are found, on closer examination, to pass almost imperceptibly into each other. This peculiarity is often to be observed in almost all localities where these rocks are found. The so-called "leaf beds" are of a greyish-purple tint, and contain many impressions of flag-like, parallel-veined leaves, which, though distinct enough when freshly taken from the bank, it is impossible to preserve, on account of the crumbling nature of the matrix. The ironstone, though generally forming extensive sheets, is nodular in structure, and varies much in thickness. It weathers a bright, brownish red, is hard, compact, and very heavy, and on fresh fracture is bluish to yellowish-grey.

Sections between Rough Bark Creek and Wood End.

A short distance south of this locality the bank shows the following section very perfectly (Plate I. A., Fig. 2):—

Section 2.

	Feet	in.
Prairie sod.		
1. Mixed shale and drift	7	0
2. Lignite	6	6
3. Greyish sandy shale (about)	4	0
4. Lignite	1	6
5. Greyish and yellowish well-stratified fine sandy and shaly clays	14	0
6. Ironstone (nodular)	0	4
7. Greyish and whitish clay	2	0
8. Carbonaceous shale	1	0
9. Grey soft sandstone	1	8
10. Lignite	1	0
11. Grey and yellowish laminated sandy clay	5	0
12. Ironstone (nodular)	0	3
13. Lignite	1	7
14. Carbonaceous shale	1	6
15. Lignite	2	2
16. Grey sandy clay	2	0
17. Lignite	1	5
18. Sandy underclay with large and small roots badly preserved	1	6
19. Lignite	3	2
20. Greyish sandy clay		
	57	7

The lower lignite beds are of excellent quality, firm and compact, and in some places show spots of fossil resin. The structure of the component wood is also in many instances very plainly apparent. The upper lignite, lying immediately below the surface, is soft and decomposed where shown, being in many places penetrated by roots from above. It might, however, prove equally compact with the lower beds where undisturbed. Layer 18 is one of the few instances in which lignite was actually observed to lie on an evident underclay, with roots. The ironstones are specially good and compact in this section. Owing to the wearing away of the softer strata a large quantity of this material strews the surface of the hillside.

This section does not correspond at all with the last, though situated only a few hundred yards from it, and if no fault or break in the strata intervenes—and there is no appearance of any such—the horizontal uncertainty of the deposit must be very great. Fragments of a vesicular material, resembling scoriaceous lava, are abundant in this locality. This substance is produced by the combustion of the lignite beds.

Nearly three miles southward from the last mentioned locality, in following up the valley, another very good section occurs on the east side of the stream, where in one of its many devious windings it has undermined the bank. This section is specially interesting, as affording one of the best localities for the collection of shells of mollusca characteristic of the formation. The section is as below, measurements being estimated :—

Section with shell bed.

Section 3.

	Feet	in.
Sand and sandy clay, stratified, and yellowish in general colour	40	0
Lenticular mass of poor clay ironstone, running out rapidly in both directions	2	6
Grey sand	2	0
Shell bed	1	6
Lignite	2	6
Sand and clay	10	0
	58	6

The shell bed is of hard grey sandy clay, and in some places is very full of shells, which are also less crushed, and in a better state of preservation than is usual in this formation. The most common mollusc is *Goniobasis Nebrascensis* M. & H., which occurs in all stages of growth, and several varietal forms. Fragments of *Unio* and *Viviparus*; and a few examples of *Corbula* (*Azara*) *mactriformis* M. & H. The latter must be considered a brackish-water type, but with this exception no brackish or salt-water forms have been found in these sections of the Souris Valley. The mollusca exactly resemble those of the Fort Union or Great Lignite Group, of the Missouri, and fix with certainty the stratigraphical position of the beds here represented. Fossils.

In the water of the stream, at this place, are several large spheroidal sandstone concretions which have a tendency to split into layers parallel to their flattened surfaces—one of them measuring four or five feet in diameter. These do not appear in the bank, but probably have been washed out of the lower part of the section, which was not so clearly shown.

South of the last section, and about one mile nearly due north of the position occupied by Wood End Depot, is situated an exposure showing the most valuable lignite bed I have seen in the Souris Valley. The beds are arranged thus :— (Plate I. A, Fig. 1.)

Section near Wood End.

Section 4.

	Feet	in.
1. Drift material (about)	8	0
2. Yellowish and gray stratified sandy clays, obscured in most places by slips of the bank	52	0
3. Lignite	7	3
4. Grey soft arenaceous clay	1 or more.	

Thick bed of Lignite.

The base of the lignite is about twenty-five feet above the level of the river below, and this part of the section, though apparently consisting of yellowish sandy clays like those overlaying it, is obscure. The lignite is continuously visible for at least two hundred feet along the face of the bank, and seems to preserve uniformity of character and thickness. Externally it is often crumbling, and mixed with clay which has penetrated its joints from above; but where newly exposed, it is hard and compact. It is quite black on freshly fractures surfaces, but has a brown streak, and in many places the structure of the original wood is quite discernable. Some surfaces are strewn with fragments of mineral charcoal like that found in many true coals. Other specimens are apparently structureless, and resemble cannel coal in appearance, though not in composition. The upper beds of arenaceous clay yield a few poorly preserved shells (*Viviparus*).

On the opposite side of the river valley, near this place, the upper part of the bank shows a good section of arenaceous clay, below which, and some fifteen or twenty feet below the prairie level, is a seam of lignite of good quality, four feet in thickness. This lignite bed would seem to occupy a position stratigraphically superior to the last.

Somewhat further up the stream, and on the same side of the valley, about sixty feet below the prairie level, and sixteen feet above the river, a bed of lignite occurs, of which the upper three feet only are visible (Section 5). The bank above it is not well exposed, but appears to consist of sandy clays. The lignite is of good quality, but much weathered at the outcrop. It may very probably represent a continuation of that of the last section.

The whole of these deposits, though in some places showing a dip amounting to a few degrees in one direction or other, appear to have no determinate direction of inclination, but over large areas are as nearly as possible horizontal.

Gap in the Section on the Boundary Line.

Extensive drift-covered region.

West of Wood End, the Souris Valley runs northwestward along the the base of the Coteau, diverging rapidly from the Boundary-line. It loses, at the same time, its abrupt character, and no sections either of Tertiary or Cretrceous rocks occur on it for a long distance. In following the forty-ninth parallel, the escarpment of the third great prairie steppe is first ov.ercome, and it is not until after having passed through the broken Coteau belt, and reached the Great Valley, that exposures of the underlying rocks are again found. This valley is the most eastern great erosion which crosses the Line southward, toward the Missouri, and in it the beds of the Lignite Tertiary are exhibited on a grand scale.

There is thus a space of eighty-two miles from the 263 to the 345 mile point, measured westward along the Boundary-line from the Red River, completely shrouded by drift deposits. There is every reason to believe, however, that the Lignite Tertiary beds stretch uninterruptedly between the two localities, and an exposure of these rocks some distance north of the Line helps to sustain this view.

Small exposure on Traders' Road.

This small exposure was discovered at a locality on the meridian of the 309 mile point, but nearly twenty miles north of the Line; where in going westward by the Trader's Road to Wood Mountain, the Souris is crossed for the second time. Of the rocks at this place a very small section is seen, but sufficient to correlate them with those to the east and west. At the water's edge about eighteen inches of a bed of lignite appears, the bottom of the bed being concealed. It is overlain by several feet of greyish sandy clay, of rather fine texture. The lignite exactly resembles those described as occurring near Wood End, and in some places shows spots of amber.

Country examined on two lines.

Between Wood End and Wood Mountain,—[Long. 103° 10′ to 106° 30′] —the country was examined on two lines; the first nearly coinciding with the Forty-ninth parallel, the second following the Traders' Road above-mentioned, and at its furthest point being thirty-eight miles from the Line. In describing the geology of this region, the general plan of taking localities in succession westward will be in so far departed from as to allow the description of these in the immediate vicinity of the Line before mention of those further to the north.

Lignite Tertiary Rocks of the Great Valley and Pyramid Creek.

Great Valley.

In the gorge already referred to as the Great Valley, the beds exposed are at an elevation of about seven hundred feet greater than that of those last seen on the Souris, near Wood End; and probably at least six hundred feet above those of the northern locality above mentioned. Their exact stratigraphical relation to either of these it is, however, impossible to determine. The lowest beds seen are curiously banded clays and shales. Clay beds charged with plant remains and carbonaceous matter, and having quite a purple tint when viewed from a little distance, alternate with clays nearly white, and yellowish sandstones. Above these is a sandstone layer which though of no great thickness, has in several places produced remarkable conical mounds by acting as a protecting capping for the softer strata below, the latter forming slopes or nearly perpendicular steps, according to their relative hardness, which, taken together with the distinctive colouring of the beds, gives a very striking aspect to the scenery. Above the sandstone capping of this lower part of the section, is a great deposit of sandy clays

Peculiar weathering.

and concretionary sandstones, among which three beds of lignite of various thicknesses are intercalated. The beds are almost horizontal, but undulate at low angles, and the valley of the stream appears to occupy, in the main, the centre of a shallow synclinal fold.

Character of beds.

The upper part of the section in this valley consists of at least 100, and probably 150 feet of clays and argillaceous fine sands of greyish and yellowish-grey colours, well stratified. They contain thin leaf-beds at several different levels, which are prominent from their grey-purple tint, but though containing very many dicotyledonous and flag-like leaves, from their soft and crumbling nature they do not yield determinable specimens.

This part of the section also includes at least three lignite beds. The highest of these is about 140 feet above the base of the section, and three feet or more in thickness. It would appear to be of fair quality, though much decomposed and quite crumbling at the outcrop, from the action of the weather. The next is about 120 feet above the same datum, and can be traced a very considerable distance along the face of the bank. It is five feet in thickness, but includes, where examined, several thin layers of carbonaceous shale; and though of good quality in places, does not appear to have the same uniformity in the various layers that is generally found in the coals of this region. The lowest lignite is some seventy-five feet above the base of the section, and is only a few inches in thickness.

The complete section may be thus represented:—

Section 8.

Section in Great Valley.

	Feet	in.
1. Yellowish sands and clays, lignites, &c	150	0
2. Hard grey and yellowish, somewhat false-bedded sandstone, forming a "capping rock" to beds below (about)	3	0
3. Greenish-yellow, thinly bedded fine sand	15	0
4. Soft yellowish sandy clay	2	4
5. Greyish and yellowish hard-bedded clay	2	6
6. Blackish thin-bedded clay or shale, with plant remains	5	0
7. Greyish thin-bedded clay, becoming darker toward the top (plant remains) graduating into next bed	10	0
8. Hard, pale brown, compact clay, with very few plant remains	1	4
9. Hard, whitish clay, with some plant remains, and a scattered layer of heavy ironstone balls, about a foot from the top	9	0
10. Thin-bedded grayish and blackish hard clay, with leaves, and some small groups of selenite crystals	7	0

	Feet	in.
11. Fine-bedded clay filled with leaves and plant remains, hard and rusty in the upper portion	1	8
12. Grey hard sand, with charcoal-like fragments in some places	3	0
13. Ironstone with many plant remains, mostly sedge-like blades	0	3
14. Soft grey clay		
	210	1

In certain parts of the upper portion of this section, the remains of mollusca occur in some abundance, but in a very bad state of preservation. By dilligent search, however, some specimens of *Goniobasis Nebrascensis*, and large examples of *Viviparus trochiformis* were obtained. No shells, other than those of purely fresh waters, were found. Fossil Shells.

The lower part of the section forms a group well distinguished by its colour and the perfection of its stratification from the upper, and often endures, protected by its hard sandstone (No. 2), when the more crumbling upper division has been removed. The plant remains, though occurring more or less throughout the whole section, are best preserved in the lower purplish layers. They consist chiefly of leaves of dicotyledonous trees, which appear to have fallen when mature in the course of nature, and with the change of the seasons, and floated without violence to the great lake in the fine silty deposits of which they have been preserved. *Populus*, *Cinnamomum*, *Quercus*, and other forms, are represented. Leaves and small branches of coniferous trees, referable to *Sequoia Langsdorfii*, and *Glyptostrobus Europeus*, are particularly abundant at this place. Plant remains.

Many of the crumbling hill-tops in this valley have a brick-red colour resembling that seen in parts of the Souris Valley, and due, as there, to the combustion *in situ* of the deposits of lignite. The slag or clinker produced by this action is also found here, though it was not observed actually in place.

The next stream crosses the Line at the 351 mile point. It also flows through a deep valley of erosion, and may be called Pyramid Creek, from a remarkable pyramidal hill formed of the usual clays and sands, capped by a portion of a layer of hard grey sandstone, the cement of which is calcareous. It has a tendency to break into large quadrangular masses, along intersecting jointage planes, and shows conspicuous false-bedded structure. Below this is a thickness of about fifty feet of rather incoherent fine yellowish sand, sometimes argillaceous. This, producing a sloping bank, is not very well seen, but constitutes about one-third of the thickness of the beds exposed in the valley. The middle third consists of soft crumbling sandstone, or compact sand Pyramid Creek.

without any apparent cementing matter, and of which the constituent particles are rather coarse, and contrast strikingly in this respect with the overlying material. It shows evidence of having been deposited by water in rather rapid motion, through its entire thickness, but the false-bedding is very definitely cut off at many different horizons by perfectly horizontal planes, above which it again commences. The weather acting on these beds causes the hillsides composed of them to assume a well-marked terraced appearance, on a small scale, each horizontal break producing a terrace level. The sandstone contains here and there a few poorly preserved shells, among which can be recognized two species of *Goniobasis*, fragments of *Viviparus*, and of *Unio*. In one place a layer of ironstone, about three inches thick, is seen to run for some distance, The most notable feature, however, of this part of the section, is the remarkable concretionary character of some layers of the sandstone. The concretions are hard, and of all shapes and sizes. They are generally spherical or spheroidal, and two or more of them are often confluent, forming dumb-bell-like masses, or more or less continuous sheets of a lumpy character. Many are long and root-like, and project in a singular way from the bank.

Fossil Shells.

Concretions.

The lower third of the section in this valley is—as seems often to be the case with the lower layers of these rocks—much more clearly defined, and divided into thinner beds, in which dark colors preponderate. Altogether the section here much resembles that seen in the last great valley. The lower beds of this, probably correspond with the purplish leaf-beds there, and the great thickness of sands and sandstones above, correspond in a general way; though in this place they differ in the absence, so far as could be ascertained, of beds of lignite. The layers of hardened sandstone must also in this case occupy different horizons in the two sections, but this is not to be wondered at, when the extremely local, and often nodular character of the induration is considered, and the fact that it merely depends upon the introduction of a small proportion of calcareous cement among the particles already compacted by pressure.

Section in Pyramid Creek.

The whole section in Pyramid Valley may be represented thus:—

Section 10.

	Feet	in.
1. Hard capping sandstone (several feet)		
2. Soft yellowish sandy beds, forming a sloping bank (about)........................	50	0
3. Soft sandstone, grey, false-bedded (about).........	50	0
4. Stratified sandy clay	3	0
5. Purplish plant beds with thin layers of lignite and much selenite in thin sheets, isolated crystals and stellar groups..................................	3	0

		Feet	in.
6.	Lignite, with many spots of amber	1	6
7.	Purplish bed, with a few plants	2	0
8.	Grey slightly coherent sand, with nodules of arenaceous selenite crystals	4	0
9.	Purplish bed, with obscure remains of leaves	1	0
10.	Incoherent arenaceous clay and sand	7	0
11.	Purplish-grey arenaceous clay, with obscure plant remains and some fossil wood	3	0
12.	Brownish clay with ferruginous layers	6	0
13.	Lignite	1	0
14.	Brown earthy bed	0	6
15.	Grey somewhat coherent coarse sand, with argillaceous matter	12	0
	About	144	0

The rocks show no well marked dip, but appear to undulate slightly at very low angles.

The occurrence of gypsum, as selenite, was observed here and elsewhere, to be nearly always in association with plant-beds, and generally with those holding many half-obliterated vegetable remains, and of a purplish shade. This association is not accidental, but brought about by the action of the included vegetable matter, which, while still undergoing decomposition, would facilitate the deposition of iron pyrites by the deoxidation of iron compounds in presence of organic sulphur compounds. The porous character of the plant-beds, at a subsequent period, would allow the passage of surface waters containing oxygen; leading to the decomposition of the pyrites, the formation of sulphuric acid, and by its action on the clays, of selenite or calcic sulphate. Association of Selenite.

A few miles west of Pyramid Creek several hills are capped with heavy and hard sandstone beds, a feature quite exceptional in a country so gently undulating. These do not appear to be perfectly horizontal, but have a slight dip to the west. They may be equivalent to the capping sandstone of the Pyramid Hill, but more probably are yet higher in the series.

Ten miles west of Pyramid Valley, in the upper part of the valley of another stream, yellowish and grey stratified sandy clays are again seen, but are not perfectly exposed.

With the exception of this exposure, the underlying rocks are nowhere clearly visible in the vicinity of the Line from Pyramid Valley to Porcupine Creek, a distance of about thirty-five miles. One very considerable stream is crossed about midway, but its valley is wide, and with gently sloping banks. Highlands appear to the north, and may possibly show sections of strata overlying those seen in the Concealed interval.

banks of the streams, but I was unable to reach them, the ground, especially in the vicinity of these highlands, being covered with snow, and the time at my disposal limited.

Lignite Tertiary Rocks of Porcupine Creek.

In Porcupine Creek and its tributary valleys, many partial sections occur. Lignite is seen in three places near the forty-ninth parallel, and just above the level of the brook in each instance. The exposures seem to belong to a single bed, and if so, nearly a mile of its horizontal extent can be traced. The lignite and associated beds undulate slightly in all the sections, the former decreasing from four feet in thickness in the most northern bank to one foot in that furthest south. The overlying rocks consist of yellowish and grey sands and clays, well stratified, and much resembling those forming the upper part of the section in the Great Valley.

Section in Porcupine Creek.

The best exhibition of these strata was obtained in a bank about forty feet in height, on removing the decomposed material from the surface. The section was carefully measured as follows:—

Section 11.

	Feet	in.
1. Soil.		
2. Quartzite drift, several feet.		
3. Soft greenish sandy clay, 2 feet or more.		
4. Soft blackish clay	1	6
5. Rusty crumbling sandy clay	0	6
6. Grey clay, with some plant remains	9	0
7. Grey clay, with well preserved dicotyledonous leaves.	1	8
8. Impure ironstone in concretions	0	3
9. Yellowish sand and sandy clay, with obscure plant remains	9	0
10. Greyish and yellowish fine sandy clay	1	3
11. Scattered layer of small ironstone balls		
12. Grey fine sandy clay	1	0
13. Rusty layer, with crumbling plants	0	3
14. Grey sand	0	4
15. Detached masses of lignite, showing the form of flattened tree trunks, about	0	4
16. Yellowish-grey fine sand	0	6
17. Grey clay, with plant remains	0	4
18. Lignite, not of best quality. The grain and form of component wood generally clearly perceptible. Bed undulating slightly. 3 to 4 feet.		
19. Soft grey arenaceous clay, 1 to 2 feet.		
About	31	0

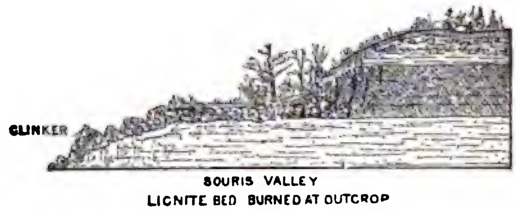


Figure 1.

Figure 2—Short Creek.

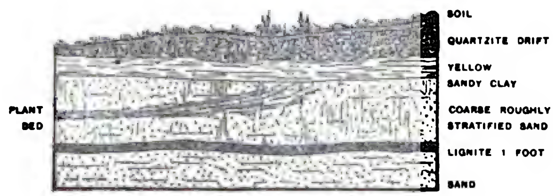


Figure 3—Porcupine Creek.

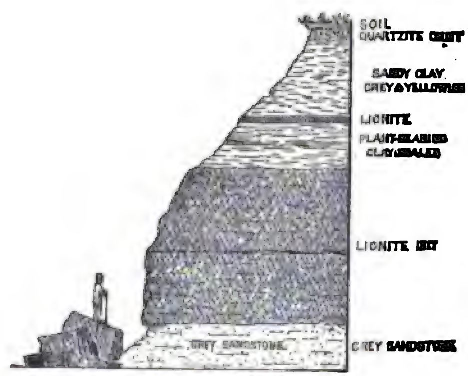


Figure 4—Porcupine Creek.

The vegetatable remains imbedded in the rocks overlying the lignite are mostly those of deciduous trees, and in certain beds are very perfectly preserved. Lignite from this section was used for camp fires, in the absence of wood, but did not burn very freely, as it was taken damp from the bed, and piled on the ground without any provision for draught from below.

The most interesting and important section, however, in this region, is that which occurs in a valley joining that of Porcupine Creek from the west, exhibiting a bed of lignite eighteen feet in thickness, and yielding also some of the most perfect and interesting remains of plants. The bank in which this out-crop is situated is over half a mile south of the Line. The beds are arranged thus:— (Plate II. A, Fig. 4.) Section with 18 foot Lignite.

Section 12.

	Feet.	in.
1. Surface Soil	1	0
2. Quartzite drift	1	6
3. Yellowish and grey sandy clays, well stratified, but somewhat soft (about)	9	0
4. Lignite	0	9
5. Banded clays, yellowish, grey and purple, with well-preserved remains of plants, and in some layers much crystalline gypsum	5	0
6. Lignite, weathering soft, some layers laminated, others rotten and brownish; forms a steep slope	10	0
7. Lignite, hard, compact, horizontally laminated, but also breaking into large cubical blocks along vertical planes	8	0
8. Soft grey sandstone much jointed, and breaking out in pieces bounded by plane faces, some vertical and others oblique; holds root-like remains and gives issue to springs of water	5	0
	40	3

Though undulating a little, the strata have no true dip, and are as nearly as possible horizontal on the large scale.

The lower part of the lignite bed is very compact and tough under the pick, and holds in some layers many drops of amber. The jointage planes form a conspicuous feature, and were not noticed in anything like the same perfection in other lignite beds examined. They cause the coal to break off in large cubical pieces which lie in the stream at its base. Some of them show thin seams of white gypsum, and in one case a thin film of iron pyrites was detected, being the first appearance of this mineral in connection with these lignite deposits. Character of Lignite.

This section also exhibits the first instance of dislocation observed to Dislocation

affect the Lignite Tertiary formation. The eighteen-foot lignite and associated strata, are seen to have been brought to their present position by a downthrow fault, on the other side of which their place is taken by underlying sandy clays.

tion of bed consumed.

The southern side of the valley, opposite this great lignite bed, is broken down, and forms a gentle though irregular slope, which is encumbered by many large, strangely shaped and coloured blocks of stone, much harder than any rocks occurring in the neighbourhood, and in pieces larger than the erratics found in the region. They proved on inspection to consist of masses of beds such as those associated with the lignite, but indurated by its combustion, which has also caused the interruption in the edge of the valley. About a fourth of a mile east on the same valley the great lignite is again exposed, and apparently in much the same development and association.

Plant remains.

The plants in layer 5, are in a beautiful state of preservation, and when the clay is first split open, show every vein-mark in perfection, not only in the larger and coarser leaves but in delicate ferns, which are here unusually common. The matrix is, however, unfortunately soft. It crumbles easily, and tends to crack on drying. A considerable number of specimens of fossil plants from the vicinity of Porcupine Creek have been preserved, though all in a more or less shattered condition. They are in the main identical with those of the Fort Union Group, and include *Glyptostrobus Europeus*, *Sequoia Langsdorffii*, *Thuja interrupta*, *Onoclea sensibilis*, and other species of ferns; and examples of the leaves of many deciduous trees. For the identification of these fossils, and the notes on them which appear in my report on the *Geology and Resources of the Forty-ninth Parallel*, I am indebted to Principal Dawson.

No molluscous remains were found in any of the Porcupine Creek sections.

Lignite Tertiary Rocks on the Traders' Road to Wood Mountain.

Traders' Road.

The furthest west of the sections in the vicinity of Porcupine Creek —that in which the eighteen-foot lignite occurs—is situated near the 393 mile point on the Line, and lies about thirty miles south-east of the trading settlement of half-breeds known as *Montagne de Bois*, Wood, or Woody Mountain. The point above indicated was the terminal one of the geological work of the season of 1873. Reverting now to Wood End, on the Souris River, the exposures of Lignite Tertiary rocks on the Traders' Road to Wood Mountain—which runs nearly parallel with, but to the north of the Boundary line—require a brief notice.

The section first met with is that already described as filling a gap in

the sequence on the Line. Westward for about ninety miles, no beds underlying the drift and surface deposits are seen in the vicinity of the Traders' Road. Beyond this point, however, for the remainder of the way to Wood Mountain—about thirty miles—many more or less perfect exposures of the rocks of the Lignite Tertiary occur.

The road here follows along the northern slope of the water-shed plateau, or occasionally crosses over one of its projecting spurs. The whole region appears to be formed of rocks of Tertiary age, against which the drift deposits of the northern extension of the Coteau, elsewhere more fully described, are found to lie.

General character of rocks. The north-eastern exposure of this series is found in a steep wooded hill, which forms the salient angle between two of the broad flat-bottomed valleys, so common in this region. The section consists of alternations of sand and arenaceous clay of light-grey and drab colours, the different layers not well defined. No hard sandstone layers crop out, and the whole of the beds are of a very soft and unconsolidated nature. A seam of impure lignite two feet in thickness occurs. It is soft, brown in colour, and holds much sandy matter. Selenite crystals are abundant, and some thin layers of ironstone are also found. The whole appears to be quite horizontal, and the thickness more or less perfectly displayed, must be over 150 feet.

The remainder of the sections from this point to Wood Mountain do not present any features of much interest, and resemble pretty closely that just described. Yellowish-grey, greyish, whitish, and drab, soft arenaceous clays and sandstones, appear with unvarying monotony in all the scarped valleys, which here ramify in every direction. No fossils, except the badly preserved remains of plants, were found, nor were lignites of any importance observed, though some of the men on a hunting excursion, some miles south of the road, brought back samples of a fair quality.

*Rocks near Wood Mountain.**

General character of beds near Wood Mountain. In the immediate neighbourhood of the half-breed settlement of Wood Mountain, no good exposures were observed. Where rocks are seen they are generally hard greyish sandstones, which protrude here and there in the sides of the hills, and banks of valleys, the softer intervening beds being concealed. These sandstones no doubt belong to the Lignite Tertiary, and probably occur at several different horizons. They have much to do with the definite shape of the watershed plateau, which but for them would probably have been but a diffuse ridge.

* The name Wood, or Woody Mountain, is sometimes used to designate the whole, or an indefinite part, of the Tertiary watershed plateau. It is here restricted to the half-breed settlement and its immediate vicinity.

South-west of Wood Mountain, on the trails used by the half-breeds of that place in going to Fort N. J. Turney—a small trading past south of the Line—ravines cut in the southern edge of the watershed plateau show occasional sections of the Lignite Tertiary rocks. At nineteen miles from Wood Mountain, by odometer, the edge of the plateau is reached, and a few miles further on, the trail crosses the junction of the Tertiary and Cretaceous, and passes out on a lower level plain based on the latter formation. Near this place, an exposure shows several seams of lignite, one of which appeared to be of good quality and considerable thickness, though not sufficiently well exposed for measurement. This bed turns out from the bank in which it occurs, a copious spring of cold water, with a very slight ferruginous taste. The associated beds are thick arenaceous clays of purplish-brown colour; soft, and containing some selenite in crystals.

Sections in the Bad Lands South of Wood Mountain.

The most instructive section, however, in the Wood Mountain region, lies twenty miles south of the settlement of that name, on the forty-ninth parallel near the 425 mile point from Red River. Here beds undoubtedly belonging to the Lignite Tertiary formation—which, east of this locality has covered so great an area of country—are found clearly superposed on indubitable Cretaceous rocks. The exposures are numerous, and are produced by the streams flowing from the southern escarpment of the water-shed plateau above referred to, which has here been gashed by their action into most rugged *Bad Lands*.

Bad Lands.

This term has attached to it in the western regions of America, a peculiar significance, and is applied to the rugged and desolate country formed where the soft, clayey Tertiary formations are undergoing rapid waste. Steep irregular hills of clay, on which scarcely a trace of vegetation exists, are found, separated by deep, nearly perpendicular-sided, and often well nigh impassable valleys; or, when denudation has advanced to a further stage—and especially when some more resisting stratum forms a natural base to the clayey beds—an arid flat, paved with the washed-down clays, almost as hard as stone when dry, is produced, and supports irregular cones and buttes of clay, the remnants of a former high-level plateau. Denudation in these regions, proceeds with extreme rapidity during the short period of each year, in which the soil is saturated with water. The term first and typically applied to the newer White River Tertiaries of Nebraska, has been extended to cover country of similar nature in the Lignite Tertiary regions of the Upper Missouri, and other Tertiary areas of the west. In the Bad Lands south of Wood Mountain, the hills assume the form of broken

Their formation and character.

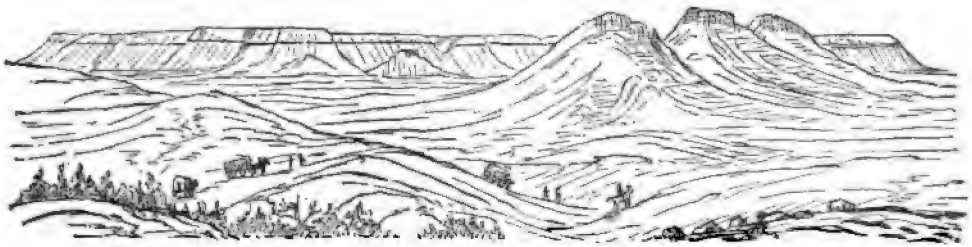


Figure 1—Effects produced by combustion of Lignites—Bad Lands south of Wood Mountain. a. a. a.—Buttes capped with altered sandstone and slag. The dark line on the distant escarpment represents the lignite bed where unconsumed.

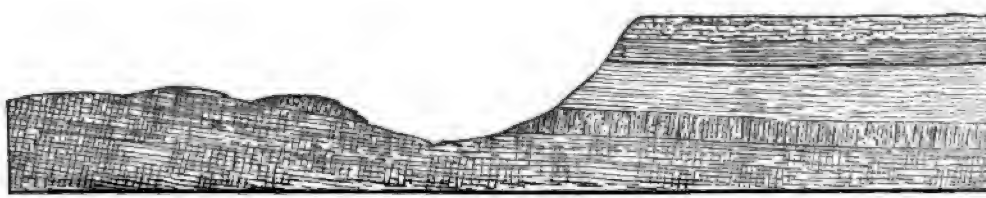


Figure 2—Junction of Cretaceous and Tertiary—Section in Bad Lands south of Wood Mountain.

The asterisk indicates the horizon on which vertebrate remains were found.

plateaux, degenerating gradually into conical peaks, when a harder layer of sandstone, or material indurated by the combustion of lignite beds, forms a resistant capping. When no such protection is afforded, rounded *mud-lumps* are produced from the homogeneous arenaceous clays. Waste proceeds entirely by the power of falling rain and the sliding down of the half-liquid clays in the period of the melting snow in spring. The clay hills are consequently furrowed from top to base, by innumerable runnels converging into larger furrows below. The small streams rapidly cutting back among these hills, have formed many narrow steep-walled gullies, while the larger brooks have produced wide flat-bottomed valleys at a lower level, in which the streams pursue very serpentine courses. Denudation is even here, however, still going on, as from the frequent change in the channel of the stream, it is constantly encroaching on the banks of the main valley, undercutting them and causing landslips. The method of the immense denudation of Tertiary beds, which is proved to have taken place over the area of the western plains, is explained by that still in progress in this way along their present borders.

The general section at this place, which though not exposed as a whole at any one spot is remarkably clear, is naturally divided into four parts.

Taking first the highest bed seen, the order is as follows. (Plate III. A., Fig. 2.) General section.

a. Yellowish sand and arenaceous clay, somewhat indurated in certain layers and forming a soft sandstone. It produces the flat plateau-like tops of the highest hills seen. *About* 50 *feet.*

β. Clays and arenaceous-clays. with a general purplish-grey colour when viewed from a distance. *About* 150 *feet.*

γ. Yellowish and rusty sands, in some places approaching arenaceous clays, often nodular. *About* 80 *feet.*

δ. Greyish-black clays, rather hard and very homogeneous, breaking into small angular fragments on weathering, and forming earthy banks. *About* 40 *feet seen.*

The whole of the beds appear to be conformable, and disregarding minor irregularities, are quite horizontal to the eye.

The clays and arenaceous clays of the upper part of Division β. are very regularly bedded and include a lignite bearing zone. Three lignite beds, of from one to two feet each in thickness, were observed, but they are separated from each other by rather wide clay partings, and are not pure or of good quality. A bed rich in the remains of plants immediately overlies the upper lignite. It is composed of a very fine and nearly white indurated clay, in which the most delicate structures are perfectly preserved. From its soft and crumbling character, it is Lignite Tertiary.

almost impossible to obtain or keep good specimens; but, in the fragments which were preserved, a few very interesting plants appear. Of these, some are characteristic of the Fort Union Group, and identical with those of Porcupine Creek. The association of remains is that of a fresh-water pond or lake, and a fine new species of *Lemna* occcurs abundantly.

Plant remains.

In the lower portion of this division, the beds are more sombre in tint, and little differentiated by colour, which elsewhere often renders the stratification apparent. They contain some layers of sand and sandstone, which show much false-bedding and current structure, and sometimes terminate suddenly with abrupt undulations. In some places, sufficient calcareous cement has been introduced among the grains to form hard sandstones, but their thickness is never great, nor do they extend far. Much ironstone occurs in thin nodular layers, and some selenite. About one-third from the base of this division a bed was found, in which curious fruits have been preserved, referable to an *Æsculus*. which has been named *E. antiquus*. (Geology & Resources of the Forty-ninth Parallel, p. 330.)

Bones of Vertebrates.

The most interesting feature of this part of the section, however, is the occurrence of the remains of vertebrate animals. These are found exclusively in the lower portion of this division, and most of them below the fruit-bed just mentioned. They are generally closely connected with the ironstone layers, and are often themselves impregnated with that substance. They are also, unfortunately, apt to be attached to the ironstone nodules, or incorporated with them, and traversed by crack-lines, in such a way as to render it difficult to obtain good specimens. A more prolonged search among those hills than I was able to make, would, however, no doubt result in the discovery of localities where the remains are more abundant and in better preservation.

Professor Cope kindly examined the vertebrate fossils obtained in connection with the expedition. Those from this place include fragments of several species of turtles, scales of a gar-pike, and broken bones of dinosaurian reptiles. Of the turtles, two are new species, to which Professor Cope has given the names—*Plastomenus costatus*, and *P. coalescens*—and there are portions of species of *Trionyx* and *Compsemys*. The gar-pike belongs to the genus *Clastes*, and of the dinosaurian remains, though mostly too fragmentary for determination, a caudal vertebra resembles that of *Hadrosaurus*.

Cretaceous No. 5, or Fox Hill Group.

Division γ., the lower series of yellow sands and arenaceous clays, is a much better defined member of the section than division a. It is exposed chiefly in the banks of the smaller ravines, but also in the upper parts of those of the main brooks. The nodules which it contains are large and irregular, but often approach more or less closely to a

spherical form. They are arranged in horizontal lines in the exposures. No fossils were found in this part of the section.

The line of separation between divisions γ. and δ., is quite well-marked by the change in the colour. Division δ shows scarcely a trace of stratification lines. I was very anxious to obtain fossils from it but succeeded in collecting a few small fragments only. They, however, indicate purely marine conditions, and one of them is referable to the genus *Leda* or *Yoldia*. The identification of the horizon of this bed does not, however, depend on such slight grounds as these, as it was afterwards traced westward, and found to be continuous with well-marked fossiliferous Cretaceous rocks.

Portion of Lignite Tertiary represented.

Division α. and β. of this section, clearly belong to the Lignite Tertiary. They probably represent, however, merely the lower layers, and differ somewhat in lithological character and arrangement from those seen at Porcupine Creek, thirty miles east of this place, and at other localities still further eastward. These beds, no doubt, belong to a lower part of the series than is exposed in any of the sections examined between this locality and the Missouri Coteau, and are probably also older than any of those found in the Souris Valley. The beds described as occurring on the trail south of Wood Mountain, belong to about the same horizon, and it is probable that those seen in some places on the Traders' road, may not be much higher up in the series. It would appear that the conditions most favourable to the production of deposits of lignite, did not occur frequently or continue long in the earlier stages of the formation in this locality.

Division δ. being certainly Cretaceous, it only remains to classify division γ., which is so markedly different in character from the beds above and below it. This bed, I believe, represents group No. 5, of the Cretaceous, or the Fox Hill Group of Meek and Hayden. It was frequently observed at other places further west, and its relation will be more fully discussed in the sequel.

Combustion of Lignite beds.

The lignite beds occurring in division β., have been burned away over great areas in this region. Numerous red-topped hills are seen, the capping being composed of indurated clays and sandstones often with much the colour and appearance of red brick. The tops of these hills are nearly on the same plane, and this, if traced back into some of the larger hills and edges of the plateau, exactly coincides with the zone there still containing the lignite. The beds, as there exposed, however, seem hardly of sufficient thickness or importance to cause an alteration of the strata so extensive as has taken place. It is possible, from the irregular nature of these deposits, that over the areas destroyed by combustion, the lignite has been thicker and of better quality, and that the fire may have been unable to extend itself into the thinner por-

tions of the bed, where it is separated by clay partings and covered by such a great thickness of other deposits. The combustion must have taken place ages ago, as only isolated red-topped buttes now remain to mark what must have been the level of the plain at that time. (Plate III. A., Fig. 1.)

Cretaceous and Tertiary Rocks south of Wood Mountain Plateau, and between the Bad Lands and White Mud River.

Rocks south of Wood Mountain Plateau.

On proceeding westward along the Line from the sections above described, one passes over Cretaceous beds, while the southern edge of the Wood Mountain water-shed plateau—which is here coextensive with the edge of the Tertiary—follows a more or less nearly parallel direction at a distance of ten to fifteen miles to the north.

Great spread of Pierre Group.

The sombre Cretaceous clays of division *b.*, may be traced almost continuously for a distance of about ten miles. Lower beds are, however, exposed, by the general slight easterly dip of the rocks. This is proved by the fact that the sombre clays, though first seen in the bottoms of the valleys, soon form the whole mass of the hills. They attain this position much more rapidly than the slight westward slope of the surface of the country at this place, will account for. About ten miles westward, near the crossing of the forty-ninth parallel and trail to Fort N. J. Turney, where the Wood Mountain Astronomical Station was established, good exposures of these rocks are again found in the banks of the valley of a large brook. On careful examination they were found to contain fossils, and specimens of *Baculites compressus*, *B. ovatus*, and other forms characteristic of Meek and Hayden's 4th, or Fort Pierre Group, were obtained. This horizon is also indicated by their position relatively to the Tertiary and their lithological character.

Lithological character.

The rock is a soft clay-shale, which though fine and regularly stratified, from its homogeneous character hardly shows traces of its bedding. It crumbles down into earthy banks, which, however, in some places, exhibit prominent nodular bands of ironstone, and in connection with these the fossils are, for the most part, preserved. They are usually completely imbedded in the ironstone and filled with it, though the concretions must have been formed some time after the deposit of the clay, as the larger shells are completely crushed. The *Baculites* still retain to a great extent, their original nacreous lustre and play of colour. The ironstone nodules are often septarian, and from the rapid removal of the clays by denudation, the fragments strew the surface in abundance. Selenite is diffused in small quantity through all parts of the beds.

Taking into account the difference of level between this locality and that of the section of the Bad Lands, the clays here seen must be at least 200 feet below the base of division γ. The sombre Cretaceous clays of these localities much resemble in lithological characters the beds of the Pembina Mountain Group, and they also hold the same relation to the overlying Lignite Tertiary series as that assigned to those deposits. They differ chiefly in being less consolidated and darker in colour, and in forming when weathered a crumbling bank of earthy appearance, rather than one of somewhat sharp-angled shaly fragments. The scarcity of fossils in the Pembina Mountain sections, prevents any palæontological comparison of these beds with them. It must be remembered, too, that at least several hundred feet of the upper part of the Pembina Mountain Group, on the eastern margin of the basin, was not seen, and it is this very part of the series which must be represented here. Taking into account, however, the great distance separating the exposures on the eastern and western margins of the region covered by Tertiary, the lithological and structural resemblance of the deposits is quite as close as could be looked for, even in an area characterized by such wide-spread similar conditions, as the interior plateau of the continent. **Comparison with Pembina Mountain series.**

Westward from these sections, the continuity of the Cretaceous clays in the vicinity of the Boundary Line, is indicated by occasional small exposures, and at a distance of thirteen miles, a tolerably good exhibition of the rocks again occurs. They are now found to resemble very closely the clay-shales of the upper part of the Pembina Mountain series, and to differ to a corresponding extent from those last described. They are firmer in texture, and lighter in colour, and are traversed in all directions by rusty-faced cracks. The peculiar small rusty fucoidal markings, already more than once referred to, are also abundant, though other fossils are extremely scarce. A few impressions resembling fish-scales, but very obscure, were found; also a single specimen of *Baculites compressus*, being a cast of the interior of the shell in soft ironstone, with the impressions of two gasteropodous shells, which had fallen into its outer chamber. One of the latter is of naticoid type, with a short spire, and few volutions rapidly increasing in size. Not a trace of the calcareous substance of any of these fossils remains; and the clay-shale shows, in many places, obscure impressions, which apparently mark the former positions of other calcareous fossils, as in the shales of the Pembina Mountain series. Taken in connection with the indications just mentioned, the fact that two shells of different species were caught up in the body-chamber of the single *Baculite*, which owed its preservation to an ironstone concretion, would tend to show that organic remains were originally somewhat abundant, **Fossils.**

but that they have been removed by chemical action in the way already noticed.

Bleached clays. Selenite in small crystals abounds, and is generally found filling the lines of fissure. Well-marked white bands indicate the stratification lines in some places. They are occasionally several inches in thickness, and have evidently been bleached subsequently to the deposition of the clays, by the percolation of water charged with sulphuric acid, produced by the decomposition of pyrites, along the more permeable layers.

Division γ at White Mud River. Where the Line crosses White Mud River,* or Frenchman's Creek, numerous and very fine exposures of the Cretaceous rocks occur. The stream flows in the bottom of a great trough, cut out of the soft Cretaceous strata, over three hundred feet deep, and in some places fully three miles wide. Many ravines enter this valley from the sides, and numerous land-slips have brought down the upper beds to various levels in its banks, and have produced a rugged mass of conical hills and ridges. The tops of the banks on both sides of the valley are formed of yellowish ferruginous sands, referable to division γ., of the Bad Land section. They are, in many places, hardened into layers of sandstone, and are nowhere very soft. Land-slips have confused the section, but they can be traced in their original position as far up and down the valley as can be seen. I could find no fossils in these beds, though sixty to seventy feet of them must be visible in some places.

Pierre shales. Below these are sombre Cretaceous clays of division δ., and they extend downward to the water level of the river; showing a thickness of 273 feet, the base not being seen. The portion of these clay-shales most closely resembling those last described, and those of the Pembina Mountain series, lies immediately below the yellow sands. Below this, to the bottom of the valley, they show rather the crumbling earthy character and more sombre color of the Bad Lands and Wood Mountain Astronomical Station exposures. This would tend to prove that rocks like those of the upper part of the typical Pembina Mountain series, are not confined to any particular horizon in the western representatives of that group. About 100 feet below the base of the yellow sands, a bed characterized by the great abundance of the remains of a fine species of *Ostrea* occurs. It is referable to *Ostrea patina* of Meek and Hayden; and fragments of a thick *Inoceramus* appear in the same stratum. The ostreas, for the most part, are quite perfect, and have been intombed where they grew, the valves being still attached. They are frequently roughened externally, and crusted with selenite crystals,

Fossils.

* There are probably half-a-dozen streams of this name in different parts of the North-west. The best known is that at the south end of Manitoba Lake, with which this must not be confounded.

produced apparently by the action of acidulous waters on the shell itself.

A short distance below this ostrea bed is a zone containing many large septarian ironstone nodules. In some places a horizontal surface of this bed has been exposed, forming an arid wind-blown expanse of crumbled fragments of the shale, which here and there supports an *Artemisia*, and from which the nodular masses stand up at intervals, as they have been exposed by weathering. The concretions are often as much as twelve or fifteen feet in diameter, and lenticular in form, but are generally broken into fragments by the action of the frost. They hold remains of *Ammonites* and *Baculites*, the former at times two feet in diameter, and referable to *A. placenta*, a form, like *Ostrea patina*, characteristic of the 4th group of the Missouri River section. The fossils are unfortunately intersected by the cracks which traverse the mass of the nodules, in such a way as to render their preservation very difficult. Some of them retain their nacreous lustre in all its original perfection. Bleached bands like those already described, occur in many parts of these clays. Septarian nodules.

The beds here appear to be perfectly horizontal, and the increased elevation of the general surface of the country will more than suffice to account for the reappearance of the yellow sandy deposits last seen in the Bad Lands—without supposing the existence of any gentle anticlinal between the two localities. Our camp, situated a short way down the eastern slope of the White Mud Valley, and consequently somewhat below the general level of the prairie, was 445 feet above the Wood Mountain Astronomical Station, nineteen miles east, by comparison of seven barometric readings at each place. The base of the yellow sands being about 30 feet below the camp, is 409 feet above the Astronomical Station; and as the base of the same stratum (division γ.) in the Bad Land Section was found to be about 170 feet above the Astronomical Station, a difference of 239 feet between the same horizon in the Bad Lands and at White Mud River, would remain in favour of the latter. The distance being about thirty miles, gives an eastward slope of about eight feet in the mile. Dip of the beds.

Cretaceous and Tertiary Rocks—Wood Mountain Settlement to the Crossing Place on White Mud River.

The main trail going west from Wood Mountain settlement, passes for some distance along the northern edge of the water-shed plateau, and then going over it where it turns north-westward, crosses the valley of the White Mud River, sixteen miles north of the forty-ninth parallel, and twenty-three miles north-west of the exposures last Rocks west of Wood Mt.

described. Between Wood Mountain and the White Mud River the water-shed plateau is formed, as before, of the lower beds of the Lignite Tertiary, and projects like the prominent parts of a cameo, while the lower ground, and the deeper portions of the valleys of the streams, are formed of the underlying Cretaceous clays. On the trail, near Wood Mountain, small exposures of the Tertiary rocks frequently appear. About thirty-four miles west of that place, sections of characteristic sombre Cretaceous clay-shale occur, and a deep bay of these lower rocks, penetrates the edge of the Tertiary plateau from the north, in this vicinity. On ascending the plateau forming the west side of this bay, Lignite Tertiary rocks are again seen at intervals, to within about fifteen miles of White Mud River, when the road descends the western edge of the plateau, and again passes over the Cretaceous clays.

Bay of Pierre shales.

In the absence of other information for the district north-west of Wood Mountain, I would have followed Dr. Hector in provisionally indicating the border of the Tertiary as running from the Cypress to the Thunder Breeding Hills. The occurrence of a bay of Cretaceous rocks on the north side of the Tertiary plateau, however, throws doubt on Dr. Hector's supposition of the continuity of the edge of the Tertiary between the two last mentioned localities. Judging from analogy, there is reason to believe that the bay of Cretaceous rocks must extend continuously from the north side of the plateau to the South Saskatchewan River. The strata are as nearly as possible horizontal, and throughout this region it is found that a valley once cut down through the harder Tertiary rocks to the Cretaceous, does not in the lower part of its course again pass over the former. Dr. Hector did not reach the northern edge of the Tertiary between the Cypress and Thunder Breeding Hills, and it is by no means certain that there is even a continuous escarpment uniting them, as shown on the map.

Fossiliferous nodules.

Twelve miles east of the White Mud River, in the banks of a deep coulée tributary to it, good exposures of the Cretaceous rocks occur, and yield in great abundance the characteristic fossils of Meek and Hayden's 4th group. *Baculites compressus* is the most common form, and is associated with several species of *Inoceramus* and other molluscs. Specimens of *Avicula* (*Pteria*) *linguiformis* and *Acteon concinnus*, are included in the collection, and are especially interesting, as having been previously recognised by Prof. Hind, in localities further to the north,—the former at the elbow of the South Saskatchewan, the latter at Two Creeks on the Assiniboine.

The fossils resemble very closely, both in their general appearance and mode of preservation, those brought by Dr. Hayden's expeditions from the Upper Missouri. They are included in nodules of ferruginous

limestone, which, like the enclosing clays, are of dark-grey colour. The concretions occur only in certain beds of the clay, and are generally more or less septarian in character, the cracks being filled with amber-coloured calcite. In other parts of the section, beds with large ironstone concretions occur, and these usually have the same septarian character, but were not observed to contain many fossils. Selenite crystals abound in the clays, and a fibrous mineral, which may best be called a ferro-calcite, occurs in discontinuous layers parallel to the stratification; one of which was observed to be nearly a foot in thickness. This substance was also found in connection with the sombre clays of the Wood Mountain Astronomical Station exposures, and with those of the Bad Lands. It is minutely prismatic, the prisms in some cases, radiating from a centre, but more usually nearly parallel, and at right angles to the beds. It is pearly-grey within, but weathers yellowish-grey, and in that state much resembles, at first sight, silicified wood. Ferro-calcite.

The valley of the White Mud River, where crossed on this northern route, is very broad, but the banks are much reduced in height, as compared with those on the Line, and are not of the same precipitous character. The bottom of the valley is flat, and the soil being based on the Cretaceous clays without the intermediation of drift material, is barren in the extreme, and supports a scattered growth of *Artemisia*, and some salt-loving plants. The Cretaceous clays are seen in the banks, but are not well exposed.

From the Souris River region to this point near the 108th meridian, the Lignite Tertiary beds exist as a conformable deposit overlying the Cretaceous, properly so-called. They are generally nearly horizontal, and where they are cut away the lowest beds exposed are these of the Pierre Group, or Cretaceous No. 4. A portion of the northern extension of the same lignite-bearing formation is described by Dr. Bell in the Report of progress for 1873–4, p. 66, and analyses of lignites given. West of this point lignite-coals are now known to occur on several horizons in the Cretaceous series, a circumstance not ascertained at the time of publication of my report on the the *Geology and Resources of the Region in the Vicinity of the 49th Parallel.* The structure of this western region will form the subject of a forthcoming report. Note on western continuation of the rocks.

Composition and Practical value of the Lignites and Ironstones.

The coaly material of the beds above described is, for the most part true lignite, as distinguished from brown coal, being composed of flattened and carbonized tree-trunks. The fossil woods associated with Composition of lignites.

the plants, and which can be recognized in the mass of the lignites themselves, are all coniferous, and may, from their structure, have belonged to the species of *Thuja* and *Sequioa* represented by the leaves found in the accompanying clays (See Geology and Resources of the 49th Parallel. Appendix A). I have made some assays of the lignites, for the purpose of ascertaining as far as possible their economic value, and in doing so have not thought it necessary to confine my examination to those beds only which are of workable thickness, as a general comparison of the various seams, thick or thin, is of more value in giving an idea of the average quality of the lignites of the formation now known and those which further exploration may bring to light over the same region. The analyses, therefore, include a selection from the various sections, and several beds of good quality and thickness are unrepresented.

Mechanical characters.

The lignites all contain, when in the bed, a very considerable percentage of hygroscopic water, and even those which are very hard and tough under the pick at first, when exposed to the air tend from the loss of water to crack into angular fragments or split up along the layers of deposition, rendering it difficult to transport them to any distance without considerable loss and deterioration. The lignites generally present a rather unpromising appearance in the banks where they crop out, from the fact of their having undergone superficially a certain amount of fissuring and the interstices being filled with clay from above. When followed inward a few feet, however, they usually become quite solid and compact; They vary a good deal in appearance, some beds having a dull lustre almost like that of cannel coal; others, and this is perhaps the most common form, have the same black colour on faces of fracture, but tend rather to split parallel to planes of deposit and show on careful examination distinct traces of the medullary rays and rings of growth of the component wood. Other samples have almost a shaly appearance, caused by numerous layers of mineral charcoal, which is present in small quantities in nearly all the beds. Amber spots are common but generally quite small, The lignites do not soil the fingers like ordinary bituminous coal. Their powder is generally a dark shade of brown but sometimes quite black.

They all yield easily a dark brown solution when treated with caustic potash. The lignites from various beds might be designated by such names as *pitch coal, brown coal, lamellar brown coal*, &c., but it seems better, as they pass by easy gradations from one variety to another, to class them under the generic term lignite.

Water content.

Though giving below the actual amount of hygroscopic and combined water as found by analysis, it must be premised that it depends to a large extent on the conditions to which the lignites have previously

been subjected, and that by prolonged exposure to dry air, it might in many cases have been very considerably reduced. I have, therefore, thought it advisable in another place to reduce the results of all analyses to correspond to a certain percentage of moisture, that they may be better compared with each other and with foreign lignites. The high percentage of volatile combustible matters renders the difference due to slow and rapid coking in some cases very marked.

Souris Valley. Section 6. Lowest lignite, two feet three inches thick. Conchoidal fracture with rather dull surfaces and resembling cannel coal. Ash reddish-white. Analyses.

		By rapid coking.
Water	12.07	
Fixed carbon	45.44	38.90
Volatile matter	39.74	
Ash	2.75	
	100.00	

Souris Valley. Section 2. *Layer* 19. A weathered specimen separating into laminæ horizontally. Clay from overlying bed filling fissures. Ash yellowish-brown.

		By rapid coking.
Water	13.94	
Fixed carbon	45.27	38.35
Volatile matter	35.00	
Ash	5.79	
	100.00	

Souris Valley. Section 2. *Layer* 17. Weathered specimen. Black, compact, with shining faces. Ash yellowish.

		By rapid coking.
Water	12.67	
Fixed carbon	31.39	28.01
Volatile matter	49.52	
Ash	6.42	
	100.00	

Souris Valley. Section 2. *Layer* 10. Lustre dull, separating along horizontal planes. Ash light yellowish.

		By rapid coking.
Water	14.90	
Fixed carbon	36.94	36.68
Volatile matter	42.98	
Ash	5.18	
	100.00	

Souris Valley. Section 2. *Layer* 2. A weathered specimen soft and crumbling. Ash greyish-white.

		By rapid coking.
Water	17.97	
Fixed carbon	32.86	30.10
Volatile matter	44.56	
Ash	4.61	
	100.00	

Souris Valley. Section 5. Black compact lignite with much woody structure apparent. Ash yellow.

		By rapid coking.
Water	14.73	
Fixed carbon	42.48	34.07
Volatile matter	39.99	
Ash	2.80	
	100.000	

Souris Valley. Section 4. 7 *feet seam.* Hard compact black lignite, breaking with pseudo-conchoidal fracture,and showing traces of structure of wood. Ash yellowish-white, light.

		By rapid coking.
Water	15.11	
Fixed carbon	47.57	41.67
Volatile matter	32.76	
Ash	4.56	
	100.00	

Section 8. *Lowest Lignite.* Weathered specimen, crumbling. Ash grey.

		By rapid coking.
Water	18.74	
Fixed carbon	35.69	30.04
Volatile matter	40.54	
Ash	5.03	
	100.00	

Section 8. *Middle Lignite.* Weathered specimen. Soft, breaking into layers along deposition surfaces. Largely composed of comminuted charcoal-like fragments.

		By rapid coking.
Water	16.28	
Fixed Carbon	46.25	29.18
Volatile matter	33.19	
Ash	4.28	
	100.00	

Section 8. *Upper Lignite.* Out-crop specimen. Crumbling. Tends to break into layers parallel to deposition planes.

		By rapid coking.
Water	15.20	
Fixed Carbon	34.45	27.61
Volatile matter	44.43	
Ash	5.92	
	100.00	

Section 9. Out-crop specimen. Brownish. Fracture almost conchoidal. Ash yellowish-white.

		By rapid coking.
Water	15.51	
Fixed carbon	37.12	28.44
Volatile matter	42.65	
Ash	4.72	
	100.00	

Section 12. *Lower part of* 18 *feet seam.* Tough, compact lignite, separating into horizontal layers. Much amber in small spots, a good deal of woody structure apparent and some mineral charcoal. Ash light-grey.

		By rapid coking.
Water	12.05	
Fixed carbon	46.18	41.03
Volatile matter	35.12	
Ash	6.65	
	100.00	

Section 12. *Upper part of* 18 *feet seam.* Out-crop specimen. Crumbling. Ash white.

		By rapid coking.
Water	16.87	
Fixed carbon	34.32	24.30
Volatile matter	37.51	
Ash	11.30	
	100.00	

Average composition.

The lignites, it will be observed, are on the whole uniform in composition and contain an average amount of over 40 per cent. fixed carbon, when the water content is estimated at 12 per cent. They are thus inferior to the lignite coals in the vicinity of the Rocky Mountains. The lignites here described, however, gain some advantage in a practical point of view from occurring in a horizontal position and out-cropping in the sides of valleys in such a way that they might be

worked by simple adits, avoiding the expense and trouble necessary when vertical sinking has to be resorted to in the first instance.

Do not yield coke or illuminating gas.

None of the lignites in this region yield a true coke, but merely shrink somewhat in size during the expulsion of the volatile combustible matter, and turn out of the crucible in a dry incoherent powder. The volatile matter is, as might be expected, comparatively poor in luminous gases, and the lignites would, consequently, be of little use in the manufacture of illuminating gas.

Ash.

The ash is generally of pale colours; grey and white, passing into yellowish-white, being the prevailing shades. One or two only yield a deeply-coloured ash, which is then brick-red. It is small in amount in most of the specimens, and does not usually appear of a nature to form troublesome clinker. The lignites when burning yield a peculiar empyreumatic odour but no smell of sulphur, and indeed, as might be foreseen from the nature of the ash, the quantity of sulphur present is very small.

In the table opposite, the analyses of all the lignites are calculated to correspond with a quantity of water, combined or hygroscopic, equal to twelve per cent., which may, I think, be accepted for the samples examined as the practical limit of desiccation in dry air at ordinary temperatures. This will allow of a more accurate comparison of the value of those from different parts of the series.

Deterioration at outcrop.

It should be stated that, with the exception of two or three specimens, all those analysed were mere out-crop samples, and from the facility with which these lignite coals deteriorate under atmospheric influences, show a result much inferior to that which would be obtained from the same beds at some depth. Nos. 1 and 12 with one or two others were obtained from portions of the beds recently exposed by slips of the bank, and probably represent more fairly the quality of the better class of lignites. The total amount of carbon, inclusive of that which passes off with the volatile matters, varies probably between 60 and 70 per cent. The lignites do not appear to be suited for smithy purposes, and the smiths who tried them reported it difficult to obtain a welding heat. The same fault has been found, I believe, with even the best classes of similar fuels found in the vicinity of the Union Pacific Railway, and arises, no doubt, from the great proportion of volatile combustible matter to fixed carbon, and the quantity of hygroscopic and combined water. As the lignites do not coke, they would appear to be unsuited for the smelting of iron in the blast furnace. They are perfectly suited for puddling iron, and the metallurgical treatment of various ores, if burned in gas furnaces. Similar and even inferior lignites are extensively used for steam purposes in various parts of the world, and may even be employed on railways, though locomotives intended

to burn these fuels, in order to give satisfactory results, must have, compared to those worked on bituminous coal, larger grates and fire boxes, and longer boiler-tubes, giving a greater heating surface compared with the horse-power. The value of the lignites of this region lies rather in the abundant supply they offer of fuel of fair quality for local use in a country which, though adapted for stock-raising and agriculture, is practically without wood.

RESULTS OF ASSAYS OF LIGNITES, WATER BEING ESTIMATED AT AN AVERAGE OF 12 PER CENT.

Locality.	Miles West of Red River.	Thickness of bed.		Fixed Carbon.	Volatile combustible matter.	Ash.	Remarks on Ash.
1 Souris Valley. Sect. 6..	255	2′ 3″		45.48	39.77	2.76	Reddish-white.
2 " " " 2..	263	3′ 2″		46.18	35.90	5.92	Yellow-brown.
3 " " " 2..	263	1′ 5″		31.51	50.02	6.47	Yellowish.
4 " " " 2..	263	1′ 0″		38.08	44.57	5.35	Light yellowish.
5 " " " 2..	263	6′ 6″		34.82	48.30	4.88	Greyish-white.
6 " " " 5..	262		Water estimated at 12 per cent.	43.72	42.40	2.88	Yellow.
7 " " " 4..	263	7′ 3″		49.31	33.98	4.71	Yellowish-white.
8 Great Valley. " 8..	344	a few inches		38.65	43.92	5.43	Grey.
9 " " " 8..	344	5′		48.61	34.90	4.49	Grey.
10 " " " 8..	344	3′		36.92	44.95	6.13	White.
11 " " " 9..	346	4′		38.63	44.48	4.89	Yellowish-white.
12 Porcupine Valley							
Lower part.... " 12..	390	18′		46.20	35.14	6.66	Light grey.
13 Upper part.... " 12..	390	"		36.33	39.97	11.70	White.
Average................				41.10	41.41	5.55	

Ironstones.

The ironstones of this formation, though occurring very frequently in the same sections, and in close proximity to the coals, have not been observed in any place to attain a considerable thickness. They generally run in nodular sheets of only a few inches thick, through the clays and argillaceous sands. Externally they weather to various shades of chocolate brown and reddish brown, but are hard and compact in structure and within preserve their original bluish or yellowish grey colour. They ring beneath the hammer, and break off in conchoidal chips. Considerable quantities of this material might be gathered from the surface in some localities, and it is possible that further search might bring to light localities in which so many layers of ironstone occur in the same section as to render it profitable to work over the entire bank.

Clay Ironstones, Souris Valley. Section 2.

Protoxide of iron	49.00
Water lost at 115° C	1.21
Carbonic acid, lost on ignition	28.57
Siliceous matter insol. in HCl	17.04
Sulphuric acid	0.26
Phosphorus	*Trace*
Metallic iron per cent., in raw ore	38.11
Metallic iron per cent., in calcined ore	54.27

Clay Ironstone, Great Valley. Section 9.

Protoxide of iron	46.72
Water lost at 115° C	3.57
Carbonic Acid lost on ignition	21.23
Siliceous matter insol. in HCl	8.72
Sulphuric acid	0.30
Phosphorus	0.03
Metallic iron per cent., in raw ore	37.53
Metallic iron per cent., in calcined ore	49.90

A small quantity of iron is present as peroxide in each ore, but I have not thought it necessary to make a separate estimation of this.

A third specimen from the Great Valley, Section 8, examined for iron, gave a percentage in the raw ore of only 37.95.

The percentage of iron in the specimens examined is very good for the class of ores to which they belong. The average percentage of iron

of several good English clay-ironstones amounts to 33.84; of several samples of black-band ironstones to 35.39. Where these ironstones are unweathered, the whole of the iron appears to be in combination with carbonic acid. The quantity of sulphur pseesent is small, and it is entirely as sulphuric acid and in combination with lime. Phosphorus is also present in very small quantity.

The clays and argillaceous sands accompanying the lignites are in many places of the nature of fire-clays, and contain but very small quantities of iron or lime. It is probable that many of them would make very refractory fire bricks. Clay of sufficiently good quality for the manufacture of ordinary bricks and pottery is present everywhere in close connection with the lignites. Fire-clays.

APPENDIX II.

NOTE BY PRINCIPAL DAWSON, C.M.G., LL.D., F.R.S., ON FOSSIL PLANTS COLLECTED BY DR. SELWYN, IN THE LIGNITE TERTIARY FORMATION OF ROCHE PERCÉE, SOURIS RIVER.

PLATANUS NOBILIS.—*Newberry.*

This magnificent leaf, of which several very good specimens have been obtained, was first described by Dr. Newberry in the Annals of the Lyceum of New York for 1868. His specimens were from near Fort Clarke, on the Upper Missouri, and were found in beds then regarded as Miocene Tertiary, though now known to be much older, and which are on the horizon of the Lignite Tertiary Series of the Souris River. A figure of the leaf is given in Dr. Newberry's later work, "Illustrations of Cretaceous and Tertiary Plants," Geological Survey of the Territories, 1878. There can be little doubt that this plant is the same with that named by Lesquereux, *Platanus dubia*, in 1878, and subsequently described in his Report on the Tertiary Flora of the Western Territories, as *Aralia notata*. Fragments of this leaf were obtained by Dr. G. M. Dawson in the region of the Souris River in 1874, but they were too imperfect for description. The present specimens are in some respects the most perfect ever obtained. Some of them are a foot in diameter, and they show some points of structure not before noticed.

I may, before referring to these, quote Newberry's description, which is very full and accurate.

"Leaves large, one and a half feet in length and breadth, petioled, 3 lobed, or sub-5 lobed, lobes acute, margins of lobes and base entire or near the summits of the lobes delicate sinuate-toothed; nervation strongly marked, generally parallel; medial nerve straight, two basilar nerves of nearly equal length and strength diverge from it at an angle of 30°–35°, are straight throughout and terminate in the apices of the principal lateral lobes. Above the basilar nerves about 16 pairs of lateral nerves are given off from the mid-rib at about the same angle; these are nearly straight and parallel, terminating in the teeth of the margin. From each of the basilar nerves diverge about the same number

of pairs of branches as from the mid-rib, and these are also nearly straight and parallel and terminate directly in the margin. Of these the second and third exterior, one on each side, is often much the strongest of the series, and is then prolonged into a small but distinct lateral, triangular acute lobe, giving the leaf a somewhat pentagonal form. From this basilar branch of the lateral nerves, 12 or more short, generally simple branchlets, spring on the lower side, and 4–5 on the upper side, near the summit, all of which terminate in the margins. The tertiary nerves connect the adjacent secondary nerves nearly at right angles. Sometimes they are straight and parallel, but oftener more or less broken and branching where they meet, near the middle of the interspaces. Where the systems of nervation of the lateral and middle lobes come into contact, the tertiary nerves are stronger and form a somewhat irregular network, of which the areolæ are large and sub-quadrate."

The above description corresponds perfectly with Dr. Selwyn's specimens, xcept that only the right basilar nerve sends off a large branch terminating in a lobe; that on the left side having somewhat equal branches.

As to the affinities of the leaf, Newberry remarks that the texture is thicker and the surface smoother than most sycamores, resembling in this some tropical leaves; but as the radical structure is that of a *Platanus*, and the associated plants indicate a temperate climate, he refers the plant to *Platanus*.

Lesquereux, in describing his *Aralia notata*, gives nearly the same characters, except that he characterizes the secondary nerves as camptodrome, or bending before they reach the margin. He admits that he would consider it identical with Newberry's species but for this feature, and further admits that in one of his specimens the outer veins appear to be craspedodrome and terminating in small teeth, and he refers to other cases in which such characters are inconstant. In Dr. Selwyn's specimens, while in the basal part of the leaf the veins bend somewhat toward the margin, which is entire, in the upper part they run straight to the margin, and terminate in short teeth, separated by broad, shallow sinuses. Thus these specimens satisfactorily unite Newberry's and Lesquereux's species.

Dr. Selwyn's specimens, however, exhibit a peculiarity which seems to have been absent from the specimens studied by Newberry and Lesquereux, in the presence of two short basal lobes, extending backward on the petiole. Each of these is about an inch in length, pointed, and with one strong exterior tooth and two delicate nerves, one extending to the point and the other to the tooth. It does not certainly appear whether these basilar lobes are separate or united in the

middle. If the latter, they would present some resemblance in mode of attachment to the Cretaceous leaves known as *Protophyllum*, and to the tertiary species of *Pterospermites*, from which, however, this leaf differs materially in other respects. These peculiar basal lobes are preserved only in one of the specimens, and they have been wanting or concealed in those figured in the United States Reports.

In Dr. Selwyn's specimens the petiole is four inches long in a specimen about a foot in diameter. It is channelled, woody in texture and with an articulating surface at the proximal end. This and its great abundance on certain surfaces, shows that the leaf belonged to a deciduous tree, wnich, from the localities cited by the authors already named, must have béen widely distributed, though as Lesquereux remarks, especially abundant to the northward.

It is to be hoped that further research will disclose the fruit of this remarkable tree, and thus make its affinities more certainly known. In the meantime, I think it well to retain Newberry's name, as having priority, and quite as likely to be correct as any other. If a *Platanus*, the tree must, as Newberry remarks, have borne somewhat the same relation to our sycamores which *Acer Macrophyllum* of the West Coast bears to the other maples. This species would seem to be specially abundant in the *Second Group* (Evanston, Mount Brosse, &c.,) of Lesquereux's arrangement of the Lignite flora.

SASSAFRAS SELWYNI, S. N.

Leaf somewhat rough on the under side; three lobed, three ribbed, with the central lobe longest; ribs and nerves strong and woody; margin entire and slightly waved; breadth, 4.5 centimetres; length, 5 centimetres. The two lateral nerves diverge at an angle of 40° from the mid-rib. Each lateral rib gives off three small curved veins at its base, and these six strong curved veins which bend round and become parallel with the margin. Slender parallel veins are given off from the inner sides of the lateral ribs, and join those of the mid-rib up to a height of 1.5 centimetres, when the mid-rib gives off 6 strong slightly curved parallel lateral veins on each side, at angles of about 40°.

This species is represented by only one well-preserved example in Dr. Selwyn's collections. Its form and venation are very peculiar, and I think entitle it to be referred to *Sassafras* with quite as much probability as many of the leaves from the Cretaceous referred to that genus, It is indeed very near to *S. Cretaceum* Newberry, especially the variety *obtusum* of Lesquereux. It is to be observed, however, that this common Cretaceous species has also been referred to *Araliopsis*. If a *Sassafras*, it is of interest as being the first representative of that genus

from the Lignite Tertiary, and as connecting a generic form of the Cretaceous and modern floras of America with the Tertiary as well.

QUERCUS. Sp.

An oak with leaves about 1.5 inch broad, and probably 4 or 5 inches long, having strong mid-rib and numerous straight veins, terminating at the apices of abruptly-pointed teeth pointing upward. This leaf seems different from any I can find figured. Its nearest American ally seems to be *Q. antiqua* of Newberry, from the Cretaceous of Nebraska. It is probably a new species, but the specimens are scarcely sufficiently perfect to warrant its description.

Associated with these leaves are those of a *Populus*, referable to the widely-distributed *P. arctica*, of Heer, another which seems to be *P. cuneata*, Newberry, from the Fort Union group, and one which may be *P. acerifolia*, of Newberry, while a fourth resembles *P. Hookerii*, of Heer, found in the McKenzie River Tertiary beds by Richardson There are also leaves probably of a *Corylus* not unlike our modern species, and a fragmental leaf which may belong to the genus *Pterospermites.*

TAXITES OLRIKI.—*Heer.*

There are some leaves and branchlets of *Coniferæ* and *Taxineæ* on the same slabs with the other leaves. The most abundant and striking of these is a large-leaved *Taxites*, apparently *T. Olriki* of Heer, a species found in Alaska, Greenland and Spitzbergen. It is the most luxuriant in its foliage of the tertiary species of Taxites, but Dr. Selwyn's specimens are even larger and better developed than those figured by Heer.

TAXITES OCCIDENTALIS.—*Newberry.*

Taxites Occidentalis of Newberry is represented by a few small fragments, and there is a well-preserved leafy branch of a *Sequoia*, apparently *S. Langsdorffii*, though larger and richer in foliage than most of the specimens figured by Heer and others. This species also occurs at Porcupine Creek (G. M. Dawson), at Dirt Hills (R. Bell), at McKenzie River (Richardson), at Atlanta (Heer), and very extensively in the Tertiary of North America and Europe.

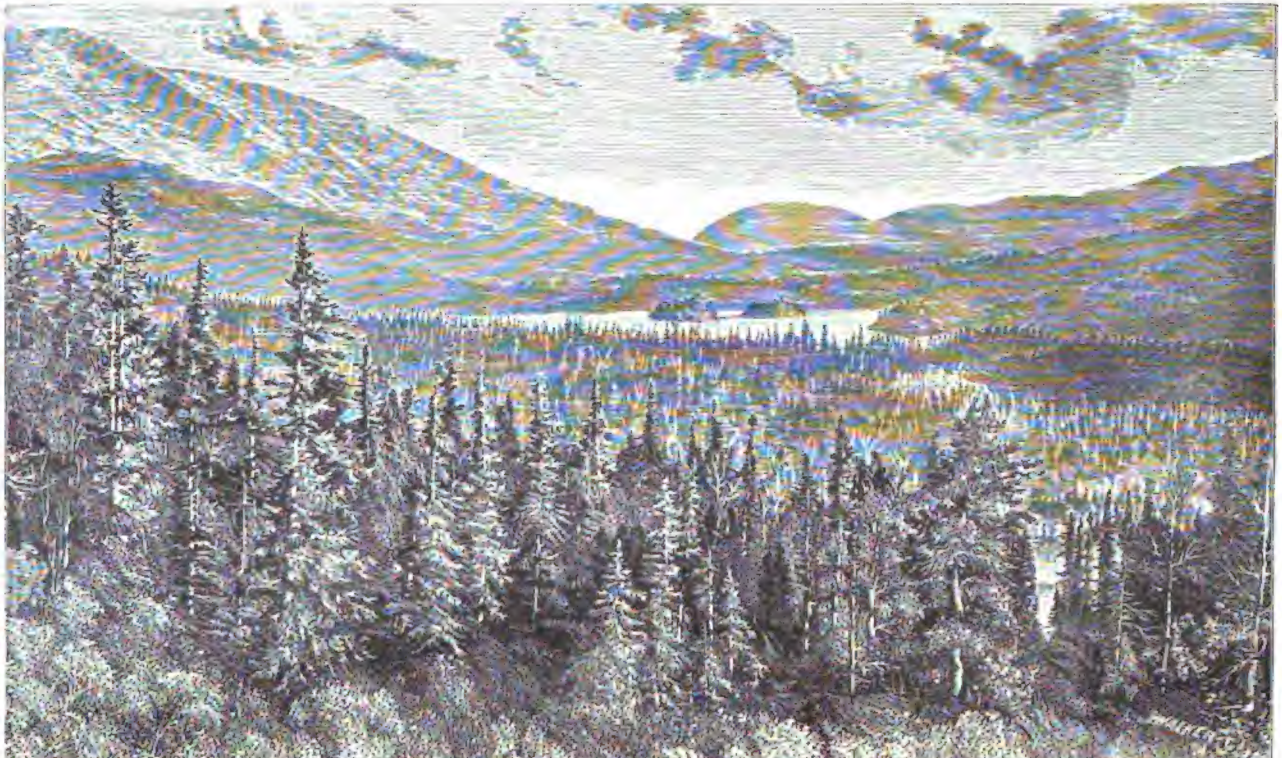
The above plants are contained in slabs of a ferruginous sandstone, which retains good impressions of their forms and venation, and is sufficiently hard to allow large specimens to be obtained.

The fossils above noticed would refer the beds containing them to the Eocene or Paleocene group designated, in the Reports of the Canadian Geological Survey and Boundary Commission, the Lignite Tertiary

series, and in Hayden's and other reports of the U. S. Survey of the Territories, the Fort Union, or Lignitic, or Upper Laramie group.

The Flora of the Roche Percée thus proves to be similar to that of the Porcupine Creek Series of Dr. G. M. Dawson's Report on the 49th parallel, to that of the Lignite Series of the Lower Mackenzie River and to that of the Fort Union group and Lesquereux's Carbon gronp, or third and highest sub-division of the Laramie group of the Rocky Mountain Region. It belongs to the great Lignite Tertiary series of the North-West, which rests on well characterized upper Cretaceous rocks; and though undoubtedly similar to that of the Miocene of Europe, really characterizes the beds which in the West constitute the transition from the Cretaceous into the Tertiary, and which form one great continuous series, probably on the horizon of the Eocene of Europe, though with local differences which are liable to be mistaken for differences of age.

Plate 1.



G. M. D., Photo. July 27, 1879.

SUMMIT LAKE, PINE PASS, LOOKING SOUTH DOWN ATUNATCHE VALLEY.

GEOLOGICAL SURVEY OF CANADA.

ALFRED R. C. SELWYN, F.R.S., F.G.S., DIRECTOR.

REPORT

ON AN EXPLORATION FROM

PORT SIMPSON ON THE PACIFIC COAST, TO EDMONTON ON THE SASKATCHEWAN,

EMBRACING A PORTION OF THE

NORTHERN PART OF BRITISH COLUMBIA AND THE PEACE RIVER COUNTRY.

1879.

BY

GEORGE M. DAWSON, D.S., A.R.S.M., F G.S.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

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DAWSON BROTHERS.

1881.

TO ALFRED R. C. SELWYN, ESQ., F.R.S., F.G.S.,

Director of the Geological Survey of Canada.

SIR,—I beg to present herewith a report on the exploration of the Northern part of British Columbia, and the Peace River Country. The Survey is indebted to Prof. J. Macoun for the determination of the plants enumerated in Appendix I., and to Principal J. W .Dawson for the preliminary note on the Cretaceous fossil plants which is incorporated in the report

I have the honour to be,

Sir,

Your obedient servant,

GEORGE M. DAWSON.

MONTREAL, March 25 1881.

NOTE.—The bearings throughout this report are given with reference to the true meridian unless otherwise specified.

The native names of places divided into syllables, are those which have been correctly ascertained, and in these the vowels are uniformly employed with their 'continental' values, the long mark (¯) being used to indicate force in special cases. The pronunciation of other Indian names has either not been ascertained with great accuracy, or the orthography has become so fixed by their insertion in previous publications on the country, as to render it inadvisable to change them.

As the map (on a scale of 8 miles to an inch) of the region referred to in the report, is too large to be conveniently bound into the volume, it will be issued separately.

REPORT

ON AN EXPLORATION FROM

PORT SIMPSON ON THE PACIFIC COAST, TO EDMONTON ON THE SASKATCHEWAN,

EMBRACING A PORTION OF THE

NORTHERN PART OF BRITISH COLUMBIA AND THE PEACE RIVER COUNTRY.

BY

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1879.

The region treated of in the present report extends from the Pacific coast of the northern part of British Columbia, through seventeen degrees of longitude, to Edmonton, on the upper part of the Saskatchewan River. For a great part of this distance, however, the exploration was necessarily limited to a single line of traverse. While, therefore, enabling large additions to be made to our knowledge of the physical and climatic features of the region, the exploration is really of the nature of a reconnoissance, and in the remote region to which it refers, it is under present circumstances impossible within the limits of a single season to carry out more detailed surveys. Area covered by the exploration.

The immediate object of the exploration of the past season was to obtain all possible information as to the physical features and economic importance of the country, for the purpose of determining to what extent it offered advantages for the passage of the line of the Canadian Pacific Railway. For the examination of the engineering features of the proposed route, several gentlemen connected with the staff of the Canadian Pacific Railway were detailed. To Mr. Sandford Fleming, Engineer in Chief of the Canadian Pacific Railway, the Geological Survey is indebted for the facilities accorded to us in connection with his surveying parties. Messrs. H. J. Cambie and H. A. F. MacLeod, with whom I was more immediately associated in the field, I have to thank for ready cöoperation and assistance in many cases. Connection with railway explorations.

The expedition occupied in all a period of seven months, extending from the 8th of May to the 9th of December. The journey from Mont- Journey.

real to Victoria was accomplished by the Union and Central Pacific Railways, and from San Francisco by steamer, in the usual manner. The mouth of the Skeena River was reached by steamer from Victoria on the 6th of June, from which date to the end of December, when we arrived at Winnipeg, Manitoba, our time was continuously occupied in travel and exploration in a region without any recognized means of conveyance.

Preliminary report.

A preliminary report on the results of the exploration was prepared at Mr. Fleming's request, and has been published by him, together with those of the engineers, in the Canadian Pacific Railway Report for 1880. In the present report many subjects touched on in that just alluded to, are treated in greater detail, more particularly the strictly geological features, which required a greater length of time for their elaboration than could be afforded in the preparation of the preliminary report. In the following pages a general description of the country in the vicinity of the routes followed, with special reference to its economic importance, is supplemented by general remarks and conclusions on the region. To this follows a connected account of the geological structure so far as it is known, the information collected serving to illustrate a general section across the Cordillera region from the west coast, to the undisturbed Cretaceous and Tertiary formations of the plains. Notes on points connected with the possible construction of a railway line are given for these places which were not examined by the gentlemen more particularly engaged in this branch of the survey.

Arrangement of matter.

PHYSICAL FEATURES AND ECONOMIC IMPORTANCE OF THE COAST REGION.

Mountain ranges.

The Coast or Cascade Range of British Columbia is that forming the high western border of the continent, but beyond it lies another half-submerged range, which appears in Vancouver and the Queen Charlotte Islands and is represented in the south by the Olympian Mountains of Washington Territory, and northward by the large islands of the coast archipelago of Alaska. In this outer range there are three remarkable gaps, the most southern occupied by the Strait of Fuca, the central being the wide opening between Vancouver and the Queen Charlotte Islands, and the northern Dixon's Entrance. To the south of these, the lower part of the valley of the Columbia appears to occupy a similar depression, through which, and by Puget Sound, a moderate subsidence of the land would enable the sea to flow, forming of the Olympian Mountain region an additional large island. Whatever the ultimate origin of the gaps holding the Strait of Fuca and Dixon's Entrance, they are features of great structural importance, and

Gaps.

are continued eastward in both cases by depressions more or less marked in the Coast Range proper. This is evidenced by the fact that the Fraser River, carrying by far the larger part of the drainage of the region lying between the Coast Ranges and Rocky Mountains, after flowing southward for several hundred miles, reaches the sea opposite the end of the Strait of Fuca; while the Skeena, whose tributaries interlock with those of the Fraser, and derive their waters from a portion of the same great interior plateau or valley, falls into the Pacific near the head of Dixon's Entrance. A second large river, the Nasse, draws its waters chiefly from the far north, and its mouth is not many miles northward from that of the Skeena. Though the Salmon or Dean River, the Bella Coola and the Homathco rise to the north-east of the Coast Range and traverse it on the way to the sea, in the region intervening between the Skeena and the Fraser, these are comparatively small streams, and drain an inconsiderable portion of the plateau, deriving the greater part of their waters from the Coast Mountains during the passage through them. **Chief rivers of British Columbia.**

The persistent north-west and south-east valley which separates the Coast Range from that forming the large islands already referred to, is occupied by the Strait of Georgia, Johnston and Broughton Straits, Queen Charlotte Sound, and the water-stretch separating Queen Charlotte Islands from the mainland, sometimes called Hecate Strait. **Persistent valley.**

The northern part of the coast of British Columbia is best represented on the admiralty charts 1923 A and 1923 B, with No. 2431 and several special plans of harbors and anchorages. It is as yet, however, very imperfectly surveyed, attention having been devoted to the complete examination of the channels lying in the direct route of steamers passing up and down the coast, while many of the larger inlets and exposed parts of the coast are still drawn from Vancouver's sketches made in the last century. Vancouver being instructed to set at rest the possibility of the existence of openings to a "North-west Passage" felt himself obliged to examine to their extremities all the inlets, and explored many places which have since been seldom visited. **Maps and charts.**

The main structural features giving rise to the present complicated outline of the coast of Northern British Columbia are comparatively simple. The most important lines of structural weakness, or of the outcrop of softer rocks, have been those, running in a north-west and south-east bearing, corresponding with the direction of the mountain ranges and the coast. These have been crossed nearly at right angles by a second series, while traces are also distinctly apparent of a meridional series. These lines, sculptured out by denudation at former periods when the coast stood at a higher level, and possibly also in **Ruling features of the coast region.**

part by glaciers, have become the valleys of the broad high region constituting the Coast Range. The axial elevations of this range are situated at an average distance of sixty to eighty miles from the coast, and from these the height of its peaks and plateaux decreases gradually and with more or less uniformity to the westward, till it at length becomes so inconsiderable that the sea flows into the valleys, forming the remarkable plexus of channels, and archipelago which fringes the coast. In conformity with the general decrease in elevation westward, the outer islands of the archipelago are low in comparison with those lying nearer the mainland.

Coast ranges.

Forests.

These islands and the coast of the mainland are almost everywhere covered with dense coniferous forest, with the exception of the mountain sides and summits which are too steep for vegetation to cling to. As seen from the water, the trees frequently appear somewhat scrubby and small, but on closer examination are found to be of considerable size, though in most cases not equalling those of the low alluvial portion of the Queen Charlotte Islands. The covering of soil is almost everywhere scanty, a fact connected with the absence of extensive glacial deposits, which has been referred to in former publications. This is also found to be the case in the islands, which from their low and uniform outline might be supposed to have some agricultural value. Thus it is that even were the climate more favourable to agriculture, the area of land actually available for this purpose would be very small, and with the exception of the low north-eastern portion of the Queen Charlotte Islands, is scarcely worth taking into consideration. The Indians, while living chiefly on fish, frequently cultivate small garden patches, growing potatoes and other vegetables not requiring much care, or a prolonged warm and dry summer season.

Scanty soil.

Harbors.

Dissected as the coast is with inlets, good harbors are scarce. The inlets and channels are generally deep with bold rocky shores, and are traversed by strong tidal currents. The heads of the fiords penetrating the Coast Range almost always receive rivers, each of which has formed a shoal bank about its mouth, but this usually slopes off rapidly into water too deep for anchorage. The mouth and estuary of the Skeena is shallow and encumbered with bars and banks, and is unsuited as a port for large vessels. A fine harbor like Port Simpson, therefore acquires peculiar importance in view of the possible future requirements of this part of the coast. This harbor has been accurately surveyed, and is represented on a large scale on admiralty chart No. 2426, published in 1872. It is, therefore, unnecessary to enter into a detailed description of it. It may suffice to state that it is over three miles in length, with an average breadth exceeding one mile; that it is well sheltered and easy of access, lying at the eastern end of Dixon's Entrance. There

Port Simpson.

is a considerable area of level or gently sloping ground well adapted for the erection of buildings, and the only circumstances lessening its value as a terminal port for a railway appear to be the small area of arable land in its vicinity, and certain climatic conditions subsequently alluded to.

Metla-Katla.

At Port Simpson the Hudson Bay Company has long had its chief northern post, and although the defensive measures necessary a few years since are now no longer required, the fort still maintains a somewhat formidable aspect. Besides the Company there are here a few other traders, and a number of Indians. A large and handsome mission church is conspicuous from a distance. At Metla-Katla, sixteen miles south of Port Simpson, a station of the Church Missionary Society, under Mr. Duncan, has long been established, and a large colony of Indians have come together about it. At Port Essington on the south side of the estuary of the Skeena, is a third village, chiefly inhabited by Indians, but also by one or two traders. With the exception of salmon canning establishments, these three are the only settlements on the northern part of the coast. The fisheries promise to be the most important industries for some time to come. The fish are of excellent quality, and are generally very abundant both in the Skeena and the Nasse. The salmon are taken in nets in the estuaries of the rivers, and a large number of Indians and Chinamen are employed in connection with the canning business during the season. The sea fisheries of the coast are as yet undeveloped, but the same remarks are applicable to them as to those of the Queen Charlotte Islands, made in the Report of Progress for 1878-79. On some parts of the coast the timber will doubtless be of value before many years. No mineral deposits of such a character as to induce permanent work have yet been discovered.

Port Essington.

Fisheries.

Timber.

CLIMATE OF THE COAST REGION.

The climate of the coast of the northern part of British Columbia, while not subject to great extremes of temperature, is excessively humid, with much rain at all seasons of the year and occasional heavy falls of snow in winter. Neither Esquimalt nor New Westminster, which are the only regular meteorological stations maintained on the coast of the Province, give a just criterion by which to arrive at a knowledge of the climatic conditions of other districts; for both these places—but especially Esquimalt—are sheltered from the excessive precipitation which occurs where the moisture-bearing winds first strike the high coast line. Observations maintained by myself while engaged in a geological examination of the Queen Charlotte Islands, during the summer of 1878 (published in the Report of Progress of the

Available observations.

Queen Charlotte Islands.

Geological Survey, 1878–9), fairly represent the climate of that region during a few months. Observations kept up during many years at Sitka, two and a-half degrees north of Port Simpson, and further west, doubtless represent a climate considerably worse than that of the northern part of the coast of British Columbia. It may, however, be useful to extract from these the following facts. The latitude of Sitka is 57° 3′, or about one degree north of Glasgow (Scotland). Temperature observations extend over a period of forty-five years with little interruption. "The mean temperature of spring is 41·2°; of summer, 54·6°; of autumn, 44·9°; of winter, 32·5°; and for the entire year, 43·3° F. The extremes of temperature for 45 years are 87·8° and –4·0°. However, the mercury has fallen below zero of Farenheit in only four years out of the 45, and has risen about 80° during but seven years of that period. The coldest month is January, the warmest, August; June is slightly warmer than September." The mean of the minima for seven years of the above period is 38·6°, and of the maxima for seven years, 48·9°, shewing a remarkably equable climate. The average annual amount of rain, melted snow and hail from 1847 to 1864 (with the exception of the year 1855) was 82·66 inches, or within a fraction of seven feet; and the average annual number of days on which rain, snow or hail fell, or heavy fogs prevailed, was two hundred and forty-five, or two days out of three, while it does not follow that the other days have a clear sky. Tables by Lütke, from observations in 1828 and 1829, show that on an average each year there were 170 days calm, 132 days moderate winds, and 63 days with strong winds.*

Climate of Sitka.

Rainfall.

Winds.

Probable rainfall of exposed west coast.

The average annual precipitation of moisture at the mouth of the Columbia River, eleven degrees of latitude further south, is stated to be five inches greater than at Sitka, and it is therefore probable *a priori*, that in the vicinity of Port Simpson and about the mouth of the Skeena, on that part of the coast of the mainland lying open to the westerly winds between Queen Charlotte and Vancouver Island, and on the west coasts of these islands, that the precipitation is at least equally great, and amounts to between 80 and 90 inches per annum. This amount of precipitation, though small in comparison with that of a few exceptional places on the earth's surface, is greater than that characterizing even the western coasts of the British Islands, with the exception of a few peculiarly situated mountainous localities, where it is exceeded, and little less than the heaviest rainfall on the Norwegian coast (90 inches).

Climate of Fort Tongass.

Recently published observations for Fort Tongass, though covering a period of but little over two years, are very interesting in this con-

* Alaska Coast Pilot, 1869, and U.S. Pacific Coast Pilot, Appendix 1, 1879, p. 30.

nection, and must represent the climate of the region in the vicinity of Port Simpson and of the Queen Charlotte Islands pretty closely, as Tongass is situated on the north side of Dixon's Entrance, a little over fifty miles from Port Simpson in a direct line. The mean temperature is here 46·5°, or considerably warmer than Sitka. "This may be due," Mr. W. H. Dall writes "to the reception in the open throat of Dixon's Entrance of the warm waters of the Alaska Current, fresh from the great North Pacific Gulf Stream." Fort Tongass is the locality of the greatest known precipitation in Alaska, the rainfall averaging during the years of observation 118·3 inches, on which Mr. Dall remarks, that observations point to the Queen Charlotte Islands, and the region about Dixon's Entrance as the most rainy part of the north-west coast. At Tongass about two hundred days a year are either rainy or snowy, a proportion agreeing nearly with that observed at Sitka.* Excessive rain fall.

The excessive rainfall, considered in conjunction with the fact that the sky throughout the year is essentially cloudy, preventing rapid evaporation and keeping the dew point near the actual temperature of the air, accounts for the peculiar character of the vegetation, and the fact that ordinary cereals cannot be grown in the districts exposed to these conditions. At Port Simpson, on the west coast of the Queen Charlotte Islands, and elsewhere, many of the hills are but partially covered with forest, the remainder of the surface being occupied by sphagneous moss several feet in depth, and saturated with water even on steep slopes. The low north-eastern part of the Queen Charlotte Islands is in great measure sheltered from the rain-bearing winds, and constitutes, in fact, the only extensive area of land which appears to be suitable for agriculture on the northern part of the coast. Mr. Duncan of Metla-Katla, who kept a meteorological register for some time after his arrival in the country, estimated that there were on an average about seven fine days in a month at that place. The behaviour of the winds and barometer in both Vancouver and the Queen Charlotte Islands, appear to indicate that the centres of most storms, travelling from west to east, pass to the northward of the coast of British Columbia. This being so, it is probable that the force of the gales is somewhat greater on the northern part of the coast of the province than on the southern. Effect on vegetation. Paths of storms

I have elsewhere stated that fogs do not seem to occur with such frequency in the vicinity of the Queen Charlotte Islands as in the southern part of the Strait of Georgia. It may be interesting to quote, in this connection, the following statement by the great but unfortunate navigator, La Pérouse, bearing on the northern part of the west coast. Fogs.

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* Pacific Coast Pilot, Appendix 1.

* He writes: "I first thought these seas more foggy than those which separate Europe and America, but I should have been greatly mistaken to have irrevocably embraced this opinion. The fogs of Nova Scotia, Newfoundland, and Hudson's Bay have an incontestable claim to preeminence from their constant density."

Mild climate dependent on Japanese current.

The cause of the exceptional mildness of the climate of this region is to be found not alone in the fact of the proximity of the sea, but in the abnormal warmth of the water, due to the Kuro-Siwo or Japanese Current. The average temperature of the surface of the sea, during the summer months, in the vicinity of the Queen Charlotte Islands, as deduced from a number of observations taken by myself in 1878, is 53·8°. Between Victoria and Milbank Sound, by the inner channels, from May 28th to June 9th, the average temperature of the sea surface was 54·1°. In the inner channels between Port Simpson and Milbank Sound, between August 29th and September 12th, 54·5°; and from the last mentioned date to October 18th, about the north end of Vancouver Island, and thence to Victoria by the inner channels, 50·7°. Observations by the United States' Coast Survey, in 1867,† gave a mean temperature for the surface of the sea between Victoria and Port Simpson and outside the Prince of Wales Archipelago, from Fort Simpson to Sitka, in the latter part of July and early in August, of 52·1°. In the narrower inlets of the coast, the temperature of the sea falls, owing to the quantity of cold water mingled with it by the entering rivers. These observations serve to show the existence, off the coast, of a great body of warm water, and the temperatures closely correspond with those found in similar latitudes, and due to the Gulf Stream and North Atlantic surface drift, on the west coast of Britain. The annual average temperature of the sea surface off the west coast of Britain is stated as 49°, while that of the eastern North Atlantic, influenced by the Gulf Stream, varies from 44° to 54°.‡

Temperature of sea-surface.

Analogy with the North Atlantic.

Influence of warm sea-surface on the air.

It will be observed that the summer temperature of this body of warm water appears to be somewhat lower than the mean summer temperature of Sitka. Its influence on the climate is not, however, a direct one, but is chiefly exercised in the following way:—The prevailing south-westerly winds, sweeping over the warm surface of the

* Quoted by G. Davidson in Alaska Coast Pilot.

† Alaska Coast Pilot, 1869, p. 20.

‡ "That portion of the Kuro-Siwo having a temperature of 55° F., or more, approaches the coast of North-west America in the vicinity of Vancouver Island. The precipitation is greater, and sudden meteorological disturbances are more common between latitudes 48° and 55° N. than on any other part of the coast, so far as we know. But the water near the coast is less than 55° in temperature, and may average not more than 50°." Pacific Coast Pilot, Appendix 1, p. 21.

sea are raised to its temperature, and become saturated with moisture, abstracting from it, as they do so, and rendering latent in conformity with well known physical laws, a still greater quantity of heat. When, on reaching the mountainous coast, this moisture is condensed and discharged, the latent heat becomes again apparent, and greatly raises the temperature of the atmosphere in which the reaction occurs.

Comparison of normal and local temperatures.

According to Dove's tables, the mean annual temperature of a place situated in the latitude of Glasgow, derived from the temperature of the whole northern hemisphere, should be 35°. Owing to the Gulf Stream and south-westerly winds, the actual mean annual temperature of Glasgow is about 50°, or exceeds the normal by 15°. The mean temperature of the greater part of the North American continent in the same latitude is five to twelve degrees below Dove's normal temperature, but that of the region on the west coast of America (which is related to the course of the Japanese Current in a manner similar to that of the west coast of Europe and the Gulf Stream) as represented by the above-detailed observations at Sitka, exceeds the general mean by eight degrees. The mean annual temperature of Sitka being, in fact, nearly the same as that of Montreal, ten degrees of latitude further south.

Zone of excessive precipitation.

The coast about Port Simpson and the mouth of the Skeena is very imperfectly sheltered from the rain-bearing winds by the Queen Charlotte Islands, while the islands of the coast archipelago, being for the most part of moderate elevation in this region, abstract little moisture. Where these winds first impinge on the mountainous mainland the heaviest precipitation occurs, in exact correspondence with the height to which the moist air is forced up into the higher regions of the atmosphere, and cooled there by its expansion and loss of heat by radiation. As the mountains attain a considerable elevation at the coast, and the increase in height of the peaks towards the axis of the range is comparatively gradual, the heavy rainfall of the coast is not found to be maintained in travelling eastward by the Skeena River.

The Skeena River.

Port Essington.

The village of Port Essington, or Spuksute of the natives, is situated on the south side of the estuary of the Skeena, on the west side of a point forming the angle between it and a long inlet which runs southward, and is called the Ecstall. The ground in the vicinity of the village is swampy, and rough with stumps and logs, the remains of an originally dense forest growth. Behind the little flat on which the village stands is a ridge which rises in one place to a rather remarkable conical mount. The Ecstall is referred to by Mr. H. J. Cambie*

* Canadian Pacific Railway Report, 1878, p. 38.

as the source of ice floes which encumber the Skeena estuary during a great part of the winter.

Vancouver's Exploration.

The estuary of the Skeena was first explored by Mr. Whidbey of Vancouver's staff in July, 1793. He appears to have gone no further up than the mouth of the Ecstall, and to have been too easily convinced that the inlet was one of no particular importance. To Vancouver the name Port Essington is due, and was by him originally applied to the whole estuary. It is singular that notwithstanding the diligence and skill of Vancouver in his exploration of the west coast he passed the mouths of the three largest rivers, the Fraser, the Skeena and the Nasse, without specially noting them.

Skeena Valley.

The estuary of the Skeena or Kshi-en, as the river is called by the Tshimsians, above Port Essington occupies a valley which resembles one of the inlets elsewhere penetrating the Coast Range, but has become filled with *débris* brought down by the river, so that where from the bold banks one would be led to expect deep water, it is not found. The mountains are steep, and for the most part densely wooded, but monotonous from the regularity of their rounded outlines. Their summits, though probably seldom exceeding 4000 feet, were deeply buried in snow at the date of our visit. In a few cases wide areas of bushes and swampy meadows seem to occupy the higher slopes, but frequent large bare surfaces of solid rock are visible, from which snow-slides and land-slips have removed whatever covering of soil may have originally clung.

Mountains bordering the Skeena.

The tide flows up the Skeena for a distance of eighteen or twenty miles above Port Essington. At this point the river valley narrows somewhat, and a mass of bare and rocky mountains appears on the north bank. The slopes of these are exceptionally steep and end at the river bank in bluffs and cliffs of considerable height. Between the head of tide and the mouth of the Lakelse River, a distance of thirty-six miles, the Skeena receives several streams of some importance. The valley has an average width in the bottom of from one and a half to two miles, the mountains bordering it everywhere reaching 3000 to 4000 feet at a short distance from the river. At about half way between the two points mentioned, however, the height of the mountains appears often to surpass 4000 feet, and they probably reach 5000 feet on both sides of the river west of the Lakelse. Near the Lakelse with a decreasing altitude they assume more rounded forms and show less bare rock, being covered with trees nearly up to their summits. The quantity of snow which accumulates on the higher mountains is evidently very great. In some places it has poured down the valleys during the winter, forming great heaps near the river's edge, some of which had not entirely vanished at the date of our visit.

The valley of the Kstoos or Ecstews is large, and several high ragged summits are seen up it, several miles distant. One of these the Tshimsians call by a name denoting an Indian box from the square shape of its apex.

Throughout this part of its course the dull brownish water of the Skeena flows steadily onward at an estimated rate of four to six knots an hour, sweeping round the islands and pouring through the accumulated piles of drift logs with a steady rushing sound. No reaches of slack water occur. It is evidently in general shallow, and later in the summer must show many wide gravel bars. Islands are exceedingly numerous and often so divide the stream as to cause it to occupy a great part of the valley. The islands, though presenting a considerable aggregate area of flat ground, are so low as to be subject to overflow, or where they rise above the flood level are densely covered with large cottonwoods or spruces.

Strong current.

Islands.

The Lakelse flows out of a lake of some size situated about eight miles to the southward, which is about two hundred feet higher than the Skeena at the mouth of the river. The Lakelse valley is a wide and low depression, quite different in character from those of streams joining the Skeena lower down. According to Mr. Cambie, who ascended to the lake in 1877, the valley runs through to the head of the Kitamat arm of Gardner Inlet, the watershed south of Lakelse Lake being quite low. The wide valley from the head of the Kitamat arm was noted by Vancouver at the time of its discovery in 1793. He writes*: "This termination differed in some respects from most of the others; its shores were not very abrupt, but were bounded on each side by a range of lofty mountains, which, however, were not (as had been constantly the case) connected at the head of the arm, but continued seemingly in a direction parallel to each other. The valley between them, which was three or four miles wide, formed nearly a plain, and was covered with tall forest trees mostly of the pine tribe."

Lakelse Valley and Kitamat.

Mr. J. Richardson who examined the Kitamat arm in 1874, in connection with the work of the Geological Survey, reports that it is capable of being made a fair harbor. At the mouth of the Lakelse is a small Indian village, and evidences of a former more extensive one. Salmon run up the Lakelse, according to the Indians, in great numbers.

About eight miles above the mouth of the Lakelse the Kitsumgalum River joins the Skeena from the north or north-east. It is a large stream and is ascended by the Indians in canoes for a considerable distance. On Mr. Trutch's map it is called the Kitumax. It occupies a wide valley and appears to run through to the Nasse, forming a con-

Kitsumgalum.

* Voyages, vol. IV, p. 78.

tinuation of that of the Lakelse. A small Indian village is situated at the mouth of the river. The water between the Lakelse and the Kitsumgalum we found more rapid and difficult than any we had previously met with on the lower part of the Skeena, and it is at about two miles above the mouth of the Kitsumgalum that the stern-wheel steamer Mumford reached her furthest point in 1866. The Mumford was engaged in carrying supplies for the Western Union telegraph company, and the point reached by her probably marks the limit of profitable steam navigation of the Skeena. It is indeed difficult to understand how some of the rapid reaches below this place were ascended by the Mumford.

Limit of steamboat navigation

Sip-ki-aw Rapid.

About five miles above the mouth of the Kitsumgalum is the Sīp-ki-āw fall or rapid. The course of the river is here interrupted by a mass of granite, forming a low rocky projection on the left side, which is submerged when the river is in flood. On the opposite bank the rock rises abruptly as a steep hill 600 to 700 feet high, which is continued further up stream by a range similar in elevation. The width of the river at the rapid is 400 to 500 feet only, and at the time of our visit, the water having declined considerably from its highest stage, a half submerged mass of rock was also visible in mid stream. The fall at this stage of water is about two feet only, but a body of water so great, making this descent at a single bound, forms a pretty wild rapid. Canoes are generally unloaded here and tracked up light. Ours were portaged across the rocky neck on the left bank, the stage of the water rendering that the easiest method. A steamer could only be got up the Sīp-ki-āw Rapid by warping.

Islands and channels.

From the head of the tide to Sīp-ki-āw Rapid the river is characterized by a great number of islands of all shapes and sizes. Above this point there are few. The islands are generally found to be composed of coarse gravel, with several feet in thickness of fine sandy soil or silt capping it. They seldom rise more than ten or twelve feet above the water level, and are evidently in most instances detached portions of the flat occupying the bottom of the valley through which the river flows. The coarse gravel has been deposited in the bottom of the stream, like the bars which now encumber the river, the finer overlying deposits are the result of the overflow on them of the flood waters when the river had cut down to a somewhat lower level. In ascending the river in a canoe the 'sloughs,' or narrow channels behind the islands, are followed as much as possible to escape the strength of the current, though such 'sloughs' are usually found to lead at the head of the island to a rapid and drift-pile.

Zymoetz Valley

About four miles above Sīp-ki-āw the Zymoetz River from the south-east joins the Skeena. This stream, which is of considerable size, was

explored by Mr. Cambie in 1877. It has a deep but narrow valley with steep and banks draws most of its waters from the east and north-east in the direction of the Kitseguecla, but receives a large branch called the Kitnayakwa from the south-east. The mountains among which it rises are over 6000 feet high, the snow-line being about 5200 feet early in August.

About five miles above the Zymoetz, or seventy-seven from Port Essington, is Kitsalas Cañon. The mountains here crowd closely on the river, especially on the north side, and though the cliffs and precipitous rocks are seldom over one hundred feet in height, they are rugged and the hillsides above them steep and rough. The channel of the river is also interrupted by several islands and rocks. At the lower end of the cañon the river forms a considerable expansion. Here and in the eddys in the cañon itself are the favorite salmon fishing stations of the Indians. In entering the cañon from the lower end, it is possible to ascend a certain distance in canoes by making wild dashes across the stream from the eddy at one side to that on the other. The length of the portage varies according to the stage of the water, and the water having fallen considerably from its highest on the 16th of June, we made two short portages. The first across a narrow neck of rock over which the canoes were carried as well as the cargo; the second, about 1000 feet further up, is by a path about 1000 feet long on the left bank. The canoes are tracked up here empty. Canoes descend the rapids safely without portaging.

Kitsalas Canon.

Portage.

Near the lower end of the cañon, on the right bank, are perched a few Indian houses, with some rudely executed carved posts, or totem posts of the kind common on the northern coast. Most, in this instance, are cylindrical with figures of birds at the top. At the upper end of the cañon on the opposite or left bank, is a second and larger village with eight or ten houses, a few in good order, but most in various stages of dilapidation. The latitude of this place as determined by a meridian altitude of the sun is 54° 37′ 6″. The mountains to the north of the Kitsalas Cañon at a few miles distant from the river, are estimated to reach a height of 6000 feet. On the south bank, west of the Zymoetz, is a range of similar height, which from its appearance may be granitic. These, with the mountains before mentioned, constitute the eastern side of the low valley containing the Kitsumgalum and Lakelse. West of the Zymoetz and south of Kitsalas the summits are probably scarcely less in altitude.

Indian villages.

Mountains.

From Kitsalas Cañon to Kwatsalix—a distance of about twenty-four miles—the general course of the river is nearly north and south. The axial and highest range of the Coast Mountains appears to be crossed by the Skeena in this part of its length. The river has, however,

Axial mountains of the Coast Range.

availed itself of an important structural valley, and has not cut transversely through the range. This is evidenced by the fact that the mountains at some distance from the river are higher than any in its immediate vicinity. From various points a few miles above Kitsalas Cañon fine glimpses of the higher peaks are obtained, but a better view, including the whole snow-clad sierra, some tent-like peaks of which surpass a height of 8000 feet, is gained on looking back on this region from the hills above the Forks. In several places small valleys in the upper parts of the range are filled with blue glacier ice, and one glacier which appears to be of some size is situated a few miles below Kwatsalix on the right bank. The semi-circular valley containing this, surrounded by peaks estimated at 7000 feet in height and abundantly covered with snow, is probably the finest piece of mountain scenery on the river. The glacier occupies the bottom of a narrow V-shaped valley and is probably about a quarter of a mile in width, rising up between the slopes like a broad waggon road. The ice appears from a distance to be completely covered with fallen stones and debris, and though the slope of the valley is considerable the motion of the glacier must be slow, as the stream flowing from it was at the date of our visit nearly without earthy impurity. The end of this glacier is about four miles back from the river, and was estimated to be about 600 feet above it.

Glaciers.

Rapids.

The river in this part of its course has several swift rapids, but at moderately low stages of the water the banks are well suited for poling and tracking, rendering ascent though slow not difficult. The valley continues to be about a mile and a half, and even in places two miles wide between the steep slopes of its bordering mountains. The river winds considerably, but does not make abrupt turns, and there is now in general a flat based on gravel and from ten to thirty feet or even more in height, on each side. These flats are not very heavily wooded as a rule, and though sometimes stony, and generally with a light soil, might in part, be brought under cultivation. The growth of wild peas, vetches and other plants was observed to be very luxuriant in some places where the forest had been burnt.

Gravel flats.

Coast and interior floras.

In correspondence with the position of the highest part of the Coast Range the line of division between the coast and the interior floras may be said to be at Quatsalix. It is by no means so definite, however, in this wide low valley as in the narrow and steep valleys of most other streams crossing the range. The damp-loving devil's club (*Echinopanax horrida*) and skunk cabbage (*Lysichiton Kamtschatense*) here became scarce. The last specimen of the wild crab apple (*Pirus rivularis*) was noted about ten miles below Kwatsalix. *Pinus contorta* becomes abundant on the river flats with the aspen (*Populus tremuloides*)

which grows both on these and the hill slopes. The soap berry, or *Shepherdia Canadensis*, and a few specimens of the Douglas fir were noted, and the evidence of comparatively dry summer weather is found in the greater frequency of patches of burnt forest.

Kwatsalix Cañon is merely a part of the river less than half a mile in length, where steep rocks and low cliffs come down to the water's edge. The water runs swiftly, though not so much so as to prevent loaded canoes working up by poling and without the use of the tracking line, when it is at a good stage. There are a few Indian houses about the cañon, and according to our Tshimsian Indians from Metla-Katla the dialect here spoken differs a little from that of the coast. Kwatsalix Canon.

The Kit-wan-gā Indian village is situated on the right bank of the river about twenty-four miles above Kwatsalix. There are few islands in this reach of the river, and the valley continues wide with the exception of one place four or five miles above Kwatsalix, where low rocky hills come out on the water's edge. The river is generally swift, with a few stiff rapids. Terrace flats or benches are even more prominent than before and in some places spread widely. One flat in particular, about ten miles below Kit-wan-gā, having been burnt over and grown up with grass and coppice presented a very attractive appearance. It is about a mile long, with a width of half a mile, but with rather light soil. The hills for some distance back from the river are very low, and are evidently composed of the soft rocks of the sandstone and argillite series. Higher mountains appear at some distance. A prominent group of these to the south-east being called Ish-gan-isht by the Indians. Most of the hillsides on this part of the river have been burnt over, and are largely, in some cases for considerable areas, exclusively covered with aspen second-growth. Kit-wan-ga Village. Wide flats.

The Kit-wan-gā Indian village consists of about fifteen houses situated on a flat of some extent and at a height of about twenty feet above the river. A trail leads from this place across to the Nasse River, the journey occupying, according to the natives, three long days. The houses are of the style usual on the coast but not nearly so large or well finished as those of the Hadias. There are about ten carved posts, but none of them very striking in design. Trail to the Nasse.

About seven miles above Kit-wan-gā is the mouth of the Kitseguecla River, and some of the strongest rapids we found on the river are situated in a stretch of about four miles near its confluence. Above this point to the Forks, the river though still swift, is more moderate. From Kit-wan-gā to Kitseguecla the river is narrowed in several places by the low rocky hills of Mesozoic sandstones and argillites. The Kitseguecla is a stream of some size but very rapid and apparently Kitseguecla.

unsuited for canoeing. It comes from the south-east, and a pretty low valley runs through from its sources to the Watsonkwa behind the mass of mountains known as the Rochers Deboulés. There is a small Indian village near the mouth of the river, consisting of about ten houses, quite modern and of inferior construction. This place was accidentally set fire to and burnt by some miners ascending the Skeena a few years ago, and has since been partly rebuilt, the government compensating the Indians to some extent for their loss.

Skeena Forks.

'The Forks,' or Hazelton, is situated on the left bank of the Skeena, a short distance above the junction of the Watsonkwa. It stands on an extensive flat elevated ten or fifteen feet above the river, and at the base of a higher terrace, which rises very steeply to a hight of 170 feet. Two or three traders live here, and there is an Indian village of about half-a-dozen barn-like buildings, each accommodating several families. The Indian village is quite new, and there are no carved posts, though the people speak of erecting some soon. The old village, where carved posts are still standing, is about a quarter of a mile further down stream.

Mountain ranges about Skeena Forks.

The low region about the Forks, and wide valleys of the Skeena, Watsonkwa, and Kispayox, seem to be shut in on all sides by high mountain ranges. A triangular area, circumscribed by the valleys of the Skeena, Watsonkwa and Kitseguecla is occupied by the Rochers Deboulés Range or Nil-ki-au-da of the Tshimsians. The north-east angle of this compact mountain mass is a magnificent rocky summit, with an altitude which was ascertained to be 5955 feet above the Forks, or about 6680 feet above sea level. Among some of the peaks near it a small glacier is sheltered, and great masses of snow in June still lay on the upper parts of the range. The rocky cliffs about the summit must in some places be of great height, but are dwarfed by distance. Looking back down the Skeena, the axial mountains of the Coast Range occupy a considerable part of the horizon line. The highest points probably attain an altitude of 8000 to 9000 feet. To the west and north-west the continuation of these axial mountains is concealed by a nearer range, which lies between the Skeena and the Kispayox, the summits of which are at a distance of six to ten miles from the Forks, and reach heights estimated at from 5000 to 6000 feet. The axis of this small range appears to run north-north-east and south-south-west. The summits have a peculiar reddish appearance. To the north and north-east, a massive range, from 7000 to 8000 feet in height, and holding a few little glaciers, runs north-north-west and south-south-east. It lies to the east of the part of the Skeena above the Forks, and decreases in altitude toward the north, where the Babine River breaks through it.

The Skeena district can scarcely be regarded as of much value

agriculturally. On the lower part of the river,—with the possible exception of a few islands,—there is absolutely no good land. At about twenty miles below the Forks, however, the higher terraces at the sides of the river, and a few hundred feet above its level, extend in some places several miles back from it, and show soil of fair quality composed of sandy loam with more or less vegetable matter. It is reported that the Skeena valley continues to present the same appearance further up, and it is certainly wide and low for some distance above the Forks, while a considerable width of land suited for agriculture is also found in the valley of the Kispyox to the north-westward. It is impossible to give an exact estimate of the area of arable land in this region, but it may be roughly stated at about 80,000 acres. There may also be some good land in the wide valley of the Lakelse and Kitsumgalum previously referred to, but unless in the event of some local demand arising, it will probably be long before these regions are fully utilized.

Agricultural value of Skeena district

The Skeena has been somewhat extensively used as a channel of communication between the Omenica mines and the coast for a number of years, but as the notes already given render evident, is by no means well adapted as an artery of trade. The large canoes that the Indians of the coast hollow from the cedar, are generally employed on the Skeena. These have remarkably elegant lines, and are not as might be supposed heavy or cumbrous. Large boats carrying about fifteen tons have been worked up to the Forks, but the native canoes are found better adapted to the work. Freight brought up to the Forks costs about four dollars a hundred pounds. The point to which the steamer "Mumford" ascended is sixty-two miles above Port Essington. Above the Forks the river is scarcely deemed navigable even for canoes. The ascent of the river in canoes requires the utmost skill, dexterity, and strength on the part of the crews. Paddling is of little use, and only resorted to in certain quiet reaches, or in crossing the stream. Tough hemlock poles, pointed and hardened in the fire, are generally employed, and with these the canoe is impelled foot by foot against the rushing water, till some place too strong or deep is reached, when a dash must be made for the opposite bank, or the shore of some island, and the poling there recommenced. Tracking with a line on the beach is also resorted to, but when the water is too high and has flooded the beach, it often becomes necessary to drag the canoe up along the banks by the branches of trees and half-submerged shrubbery.

The Skeena as a route to the interior.

Mode of ascending the Skeena.

VEGETATION AND CLIMATE OF THE SKEENA.

The point at which the vegetation of the coast is replaced by that characteristic of the northern interior of the province has already been

Climate of Skeena Forks.

noted, and it will be unnecessary to enter at length into the dates at which various plants were observed to be in bloom. It may suffice to state that the lower part of the Skeena exposed to the climatic influences of the coast, is distinctly later than Victoria, by probably at least ten days. The vegetation in the vicinity of the Forks, is still considerably in advance of that of many of the cultivated and thickly peopled portions of the province of Quebec. From the character of the plants met with, the rainfall at the Forks would appear to be about equal to that at Quesnel, and quite ample for agriculture, though very much less than that at the mouth of the river.

Summer and Winter temperature.

The summer temperature of the region about the Forks is often high. According to Mr. Hankin, a trader who has resided many years at this place, snow generally first falls in October, but melts again, the winter snow not coming till about the middle of December. The winter is in general steadily cold, though there is almost always a thaw in February. The thermometer has been known to reach forty-eight degrees below zero of Farenheit, and to remain for days at a time below–30°.

Advance of Spring.

The winter is in fact about the same as that of Stuart Lake, but the spring is said to open much earlier. Grass begins to grow green and some trees to bud out about the first week in April. Some cultivation is carried on. Potatoes are occasionally nipped by frost in the spring, and on two occasions have been affected by summer frosts. They are generally harvested in the end of September, but are ripe before that time, and can be obtained large enough for use about the first of July. Indian corn does not ripen, and wheat, Mr. Hankin believes would be an uncertain crop. The season of 1878 was exceptionally long, and two successive crops of oats ripened before the frost; the second being a 'volunteer crop.' In favorable seasons, squashes, cucumbers and other tender vegetables come to perfection. A few cattle and horses have been wintered here, the former requiring to be fed for five months, the latter have been kept by clearing away the snow to a certain depth in strips to allow them to scrape for grass.

Agriculture.

The climate is in general much like that of Quebec or Montreal, with the exception of the winter, which, according to the statements above given, though rather shorter, is more severe. I am induced to think that Mr. Hankin may be wrong in supposing that wheat would not succeed well about the Forks, but this must remain a matter for future experiment.

Opening and closing of the river.

The Skeena usually opens during the last week in April or first week of May. Ice begins to run in the river early in November, but the river does not generally freeze till the end of December. The river being very rapid, the occasion of its freezing is usually the occurence

of a thaw. This sets free great quantities of anchor ice, sometimes very suddenly, blocking the river and causing it to freeze over. In 1867 the river closed on the 13th of November, which was exceptionally early. The river is generally highest in July, deriving most of its water from the melting snow on the mountains. It is lowest immediately after the ice goes.

Snowfall on the Skeena.

With regard to the snowfall on the Skeena, Mr. H. J. Cambie during his survey here in 1877, gathered that from Port Essington to near the mouth of the Lakelse (54 miles), it is exceedingly heavy, reaching a depth of ten feet or more. From this place to Kitsalas Cañon it reaches, at least occasionally, a depth of six feet; while about Kit-wun-gā—sixteen miles below the Forks—it averages three feet. So far as information can be obtained from the Indians it appears to confirm these estimates. The depth on the benches about the Forks is not over one foot, but owing to local circumstances the snowfall is here considerably less than in any neighbouring locality, the average for this part of the Skeena valley being probably a little under two feet.

Meteorological observations.

Meteorological observations kept by myself while on the Skeena, from June 7th to 23rd, being taken *en route* from Port Essington to the Forks, are necessarily imperfect, and as we were engaged in travelling during the day it was impossible to ascertain the maximum temperature. The mean minimum temperature read on a good thermometer carefully placed, on nine nights, between Port Essington and Kitsalas Cañon, was 43·4° F., the actual lowest reading being 39°. The mean of seven nights from the cañon to the Forks, 43·6°, the actual lowest being 37·5°. The mean of observations taken about 6 a.m. and 6 p.m., every day, on the first mentioned part of the river is 50·8°; on the upper part of the river, 52·8°. The mean of morning readings taken below Kitsalas Cañon is 45° of evening readings, 56·4°. These, reduced for the hour and time of the year by Dove's table of corrections, derived from observations at Sitka, indicate actual mean temperature of 49·1° and 53·1°, respectively. The mean doubtless lies between these figures, but their discord shows that we have already a considerably greater range and a climate more continental in character than that of Sitka. Morning observations above the cañon indicate a mean of 46·6°. Evening observations 58·9°, which, corrected in the same way, yield 50·58° and 55·6°, as approximations to the true mean temperature.

Watsonkwa Valley.

Of the Watsonkwa River, which joins the Skeena from the south-eastward at the Forks, Mr. Cambie reports that the valley throughout its entire length is in part prairie and sustains a magnificent growth of grass, but is subject to frequent summer frosts and unsuited to agriculture.*

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*Canadian Pacific Railway Report, 1878, p. 70.

INDIAN POPULATION OF THE SKEENA REGION.

Limits of Coast and Interior Indians.

On most of the rivers of British Columbia, the Coast Indians, completely different in language and habits from those of the interior, claim the territory to the head of canoe navigation. Following this rule, they stretch much further inland on the Skeena than elsewhere. The Indians of the Forks speak the same language with the Tshimsians of the coast, with but slight dialectal difference, while those of the Ahwilgate and Kyahwilgate villages, a few miles up the Watsonkwa are people of the Tinneh or Carrier stock. Dialects of the Tshimsian are spoken for about eighty miles above the Forks on the line of the river, and up the Babine River to the cañon. The people of the Kispyox village on the river of the same name about eighty miles north of the Forks, also speak the Tshimsian language, but these and those of the upper part of the Skeena approximate in their manner of speech to the Nascar Indians of the Nasse. The Nascars have permanent villages about twenty-five miles above the tide water on the Nasse, and claim the country for about fifty miles still further up. The division between all the branches of the Tshimsians and the Tinneh or Carrier people, appears to be quite distinct.

Linguistic divisions.

The Indian population of this region is estimated as follows:—

Estimated population.

Tshimsian.	On the Skeena:	
	Kitsumgalum	25
	Kitsalas, uncertain, owing to the number of people away at the coast and elsewhere yet calling this place their home, about	300
	Kitseguecla	150
	Skeena Forks	250
	Kuldŏr, above the Forks	150
	Kispyox	350
	Kit-ka-gas, three miles up the Babine River from its mouth	400
	Kit-wun-kool, between the Skeena and the Nasse	250
Tinneh....	Ahwilgate and Kyahwilgate on the Watsonkwa	200
		2,075

For these estimates,—which must be considered as very rough approximations only,—and for several of the facts above mentioned I am indebted to Mr. Hankin.

BABINE PORTAGE.

Trail to Babine Lake.

The Skeena River above the Forks being exceedingly rapid, and the Babine River in the cañons quite impassable for canoes, and making

besides a long detour to the north, the route for the north end of Babine Lake and Omenica leaves the Skeena at the Forks. The distance from the Forks to Babine Lake in a straight line is about forty-one miles, by the trail probably about fifty. The direction is nearly due east. The trail between these places, following nearly the line of the old Indian route, was cut and improved by the Government of British Columbia a number of years ago to afford more ready access to the Omenica district. It is still used to a considerable extent, more especially by the Indians, who make a regular trade of carrying goods and provisions across at the rate of about $4 a hundred pounds. The load usually carried by a man or woman is about one hundred pounds in weight, but in many cases much more than this is taken. The pack is firmly roped together and then supported on the back by straps round the chest and forehead. 'Packing.'

Having a considerable quantity of provisions and baggage we were obliged to hire a motley crew of Indians to carry these across to Babine Lake, and on leaving the Forks on the 23rd of June we found that our carriers were twenty-three in number, including two women. Several dogs, were also pressed into the service to carry various articles belonging to the Indians themselves. The carriers advanced by stages of a mile or half a mile at a time, according to the nature of the ground, stopping every now and then for a few moments rest. Indian packers.

After ascending from the flat at the Forks, the trail passes over a nearly level bench or terrace for some miles. It is lightly wooded with poplar, cottonwood and birch, mingled with evergreen trees, and seems to have a good soil and to be fit for cultivation. Grass, with wild peas and vetches, grow in great luxuriance, and at the date above given the thickets were fragrant with wild roses. Service berries and choke cherries had attained about half their full size on sunny exposures, and wild strawberries were ripe, and abundant in some places. At about four miles from the Forks the trail comes out on the sloping hillside on the right bank of the Watsonkwa, which it continues to follow for nearly seven miles, till the Sus-kwa* just above its junction with the Watsonkwa, is reached. In following the hillside the valleys of several small streams flowing in courses of greater or less depth are crossed. The valley of the Watsonkwa, between the bases of the mountains at its sides, is wide, but the immediate valley of the river is a steep-sided trough several hundred feet in depth, and the river itself flows onward between rocky banks with the speed and impetuosity of a torrent. The Indians in this part of the country construct bridges across streams too rapid to Trail to the Sus-kwa. 'Suspension bridges.'

* A Carrier name meaning Bear River.

be crossed in canoes with safety, when not too wide for the means at disposal. These have been called suspension bridges, and are ingenious in plan. The Watsonkwa is spanned by one of these about five miles above the Forks. The river is here about fifty feet wide, rushing between rocky cliffs of about fifty feet in height. At each side two beams are placed, projecting at an angle of twenty or thirty degrees, their butt-ends being firmly planted in a rude crib-work of logs weighted with stones. The ends of the projecting beams from opposite sides are then joined by a pair of light but strong horizontal pieces which are lashed to them. The footway or floor of the bridge may consist of a single large flatted beam or of several lengths of poles spliced together and laid parallel. The footway is supended to the superstructure above described by a series of vertical poles with hooked ends, withes being used as lashing, or, as in the instance now described, telegraph wire, being a portion of that left by the Western Union Company at the time of the abandonment of their enterprise.

Tributaries of the Sus-kwa.

About six miles from the mouth of the Sus-kwa, it is joined by the Skil-o-kis, from the north, a very rapid stream fifty-seven feet wide, and two feet deep. This is crossed by a newly constructed Indian bridge like that previously described. Five miles further on, in a general eastward direction, the main valley of the Sus-kwa turns to the south-south-east, while the trail continues eastward by that of a large tributary. The sources of this stream, known as the Oo-ats-anli, are reached in about fourteen miles, and the summit passed at a distance of seven miles from the north end of Babine Lake.

Sus-kwa Valley.

The Sus-kwa valley, to the mouth of the Oo-ats-anli, is wide, if the entire distance between the steep mountains at its sides be taken into consideration, but shows terraces at several different levels, the river itself flowing in a deep narrow trough cut in these. The terraces are usually very stony and even when of considerable width are quite unsuited to agriculture. The hillsides generally have been almost denuded of trees by fire, and exhibit a rank growth of grass, wild pea, *Heracleum* and *Epilobium*, in some places already shoulder high, and offering very fine summer pasture for stock. At the junction of the Sus-kwa and Oo-ats-anli a wide flat of attractive appearance is sunk among the mountains, but is probably of no agricultural value. In following the Oo-ats-anli, the trail continues on the whole to ascend though frequent descents into the valleys of tributary streams are made. The benches are rough and irregular, and are cut across by numerous little streams. Fire has passed over nearly the whole country, leaving in some parts of the valley great forests of bleached and bristling trunks, with only here and there a cluster or belt of trees which has not been

destroyed. Where the trees are still green the ground is everywhere soft and wet. In its upper portion, and at the summit, the valley is wide and flat-bottomed with swamps and swampy meadows alternating with brush and wood. The summer trail does not cross the summit at the lowest place, but leaving the valley to the south, ascends and passes over an irregular plateau at a height of about 750 feet greater than the pass. This little plateau is quite evidently of the nature of a terrace, and its surface is strewn with water-worn and transported stones and boulders. Its height above the sea is about 4300 feet. The dense forest which has originally filled the valleys here gives place to clumps of stunted trees, with thick rapidly tapering stems, composed of many superposed annual rings of growth. On June 26th the snow had evidently not long gone from the ground and the low-growing willows were just leafing out. Streamlets ran everywhere upon the surface from one little moss-rimmed pool to another. At greater elevations on the surrounding mountains, very few trees are seen, and 4500 feet may be stated as the upward limit of the healthy growth of trees in this region.

Summit.

High terrace.

Timber limit.

The highest peaks of the range separating the valleys of the Watsonkwa and Skeena from that of Babine Lake are passed about half way from the mouth of the Oo-ats-anli to its sources, and lie to the west of the summit of the trail. A great rugged mass of mountains to the south occupies the angle between the Sus-kwa and Oo-ats-anli. This receives the name of Nĕ-tal-tzul, which was translated to me as the 'watery mountain.' It has a height of about 8500 feet, and one or more small glaciers are observed among the mountains near it. The mountain sheep is found in this part of the range, but not very abundantly. The mountain goat is common to all the ranges of this region.

Mountains.

Looking in the opposite direction from the summit plateau Babine Lake is seen stretching far to the south-eastward like a silver ribbon, its banks generally low with flats or rounded hills of moderate elevation bordering it. The weather at the time of our visit was not favourable for a very distant view, and only a portion of the snowy ranges which might otherwise have been seen to the south-east were visible. The descent to Babine Lake is rather gradual, over a somewhat broken surface chiefly composed of stony superficial deposits, not arranged in terrace form. The country is either densely wooded or bristling with windfall, the most abundant trees being *Abies subalpina*, Englm. (*lasiocarpa* Hook), *Picea Engelmanni*, and *Pinus contorta*. Before reaching the lake the trail crosses a small river called the Tzĕs-a-tza-kwa or Canoe-making river. This in low water was fifty feet wide by one foot deep, and derives its waters from the range from which we have descended.

Babine Lake valley.

Forest trees.

Lakes and Mountains of Northern British Columbia.

Group of large lakes.

The group of large lakes of which Babine is one, may be regarded as occupying two parallel valleys, which conform to the general north-westerly and south-easterly bearings which govern the main features of the whole country lying between the Rocky Mountains proper and the coast. Babine Lake, for the greater part of its length, lies nearly parallel to the Watsonkwa valley, but at its southern end bends abruptly eastward, a wide valley running through from its extremity to the head of Stuart Lake. The watershed between the Skeena and Fraser River systems is situated in this valley, Babine Lake discharging northward by the Babine River, which after following the general direction of the valley occupied by the lake for some distance, cuts across the line of the Babine Mountains and reaches the Skeena; Stuart Lake discharging by the Stuart River into the Nechacco and thence to the Fraser. The valley of Stuart Lake opens widely at its south-eastern extremity to the low country of the Nechacco and Chilacco.

Skeena-Fraser watershed.

Dimensions and heights of lakes.

Stuart Lake occupies the south-eastern part of the second or north-eastern of the great valleys above referred to; and to the north-west of it in the same line lie Trembleur, Tacla and Bear Lakes. Stuart Lake is about forty miles in extreme length, Tacla forty-six miles and Bear Lake about twelve miles, while the dimensions of Trembleur, Traverse or Cross Lake are not known. Trembleur and Tacla Lakes discharge south-eastward into Stuart Lake, while Bear Lake forms the source of the Skeena. With the generally more mountainous character of the country to the north the height of the water surface in the lakes increases being approximately as follows: Stuart Lake 2200, Tacla Lake 2271, Bear Lake 2604. Thutage or Thutade Lake still further to the north is scarcely known. It is probably the same with a long lake sketched by Mr. Madden, a prospecter in that region, and may lie in the continuation of the same persistent valley. It discharges into the south branch of the Finlay, and a fall of 180 feet in height is reported to exist not far below its outlet.

Babine Mountains.

The Babine Mountains form a well defined range from the northern bend of the Babine River (lat. 54° 40′) to the vicinity of Fraser Lake to the south-east. They appear to culminate in height between the north bend of the Babine and the Babine and Skeena Forks trail, and decrease in elevation in a south-eastward direction, departing gradually at the same time from the shore of Babine Lake and leaving a wide intervening low country.

The entire region between Babine Lake and River, the north bend of the Skeena, Bear and Tacla Lakes is filled with high and rugged

mountain ranges. The Atna or Atnah* Mountains lying north of the Babine River rise according to Mr. Horetzky to elevations of 9000 feet, and the summit of the Atna Pass by which they are crossed is 6000 feet. Bordering Tacla Lake on the south-west is a massive range which as it is crossed by the Fire-pan Pass may be designated the Fire-pan Range. Its summits are 7000 to 8000 feet in height. Further north near Bear Lake this range appears to become less homogeneous and more broken, but still continues as a high rugged mountainous country. South of the latitude of the southern end of Tacla Lake the region between the two valleys defined in a preceding paragraph, is not so mountainous, and though still broken the elevations seem seldom to exceed 4000 feet.

Atna Mountains.

Fire-pan Mountains.

To the east of Stuart Lake lies a range of limestone mountains which can be traced running far to the north-westward from high points in that vicinity. According to the best accounts of the country about Trembleur Lake, the range must there be low or wanting, but further north it resumes as the Omenica Mountains on the east side of Tacla Lake, and forms also the mountains on the east side of Bear Lake. This range is by no means so high and rugged as those previously described, Na-katl, which forms its south-eastern extremity, has a height of 4800 feet, while the Hogem Pass leading across to the Omenica gold region was proved by Mr. Horetzky to have an elevation of only 3438 feet.

Limestone range.

Still further to the east and north-east is the Omenica mining region, which is a relatively depressed but still hilly and mountainous district. Hogem on the Omenica River has an elevation of 2570 feet, while the mouth of Germansen Creek is at 2457 feet. The country between the Omenica River from Stuart to McLeod Lake has not been explored, but no high ranges are known to exist.

Omenica region.

Babine and Stuart Lakes.

Babine Lake has been so called by the French or half-breed servants of the North West or Hudson Bay Companies in allusion to the fact that the Indians living on it had the custom of wearing a wooden labret or lip-piece in the lower lip. This custom though common on the coast is not elsewhere found among the Carrier or Tinneh people of the interior, and has doubtless been a fashion acquired by them from the Tshimsians. The lake is known as Kit-koin by the Tshimsians, by the Carriers as Na-taw-bun-kut or 'long lake.' While lying in the main in a north-west and south-east bearing the actual course of the lake is rather sinuous. Its length is eighty-seven miles, while its width varies

Names of Babine Lake.

General features.

* This is the name applied by the Tinneh people of British Columbia to any foreign Indians. The Atna Pass is here so called as being that used by the Coast Indians as an avenue to the interior country.

from half a mile to five or six miles. The elevation of the lake above the sea is about 2222 feet, or twenty-two feet greater than Stuart Lake.* On the east side of the lake, near its outlet, is situated an Indian village called Wut-at, and a small trading post of the Hudson Bay Company. The Indians take here annually a large quantity of salmon by forming a weir of split sticks across the river. The salmon are dried and stored in a *cache* raised on posts in the usual way, and kept for home use or to sell to travelling parties of Indians on the way between the coast and the Omenica Mines. The canoes used in the interior lakes are far inferior to those of the coast Indians, a fact arising in part from the absence of the cedar which the coast tribes employ. Cottonwood 'dug outs,' small, narrow, slab-sided and often more or less seriously warped and out of shape on account of exposure to the sun and air, are in general all that can be obtained. On the 20th of June we left the north end of the lake in two such canoes, and being favoured with good weather reached the opposite or south-eastern extremity on the morning of July 3rd.

Salmon fishery.

Northern portion of lake.

From the north end of the lake to Na-tal-kuz—a distance of twenty-five miles—it is narrow, and much more sinuous and irregular in width than the sketches which have heretofore appeared on the maps would lead one to suppose. It has also the appearance, in this part of its length, of being quite shallow. The banks rise often to a height of 100 to 200 feet pretty steeply, and then slope more gently away to the hills which do not anywhere in the vicinity of the lake reach 1000 feet. Considerable areas are quite flat and low, and on southern exposures large tracts have been thoroughly burnt over forming slopes of rich pasturage. In many places the timber is more than half composed of aspen second-growth, and the coniferous are everywhere relieved by a mixture of deciduous trees. In passing down the lake, occasional glimpses of the high and snowy mountains which intervene between it and the Watsonkwa are caught. Several of the peaks attain 8000 feet, but after leaving the north end of the lake a wide stretch of comparatively low land intervenes between the shore and the base of the range. To the north-east is seen from a few points the wall-like and cloud-capped range across which the Fire-pan Pass leads. This surpasses the last-mentioned range in general elevation, and is everywhere heavily snow-covered.

High mountains.

Na-tal-kuz.

Na-tal-kuz is the name of a second Indian village, situated on the north side of the lake, at the extremity of a point which lies between

* It should be stated that a considerable discrepancy exists between the height here stated and that given by Mr. Horetzky. I have been unable to explain this difference, for while I feel sure that the difference between Stuart Lake and Babine here given is nearly correct, Mr. Horetzky's estimate seems to be founded on a number of correct observations. The height assigned by Mr. Horetzky is 1647 above Skeena Forks, or assuming that point to be 725 feet, 2372 feet above the sea.

it and a long arm running to the north-eastward. The surrounding region, and a prominent and nearly conical hill which stands a few miles back from the village are denoted by the same name. The village is also called Ni-to-atz, but this is a comparatively modern name and refers to a trading post of the Hudson Bay Company. This post is the most important on the lake, that at the north-east end being only occasionally visited. Both are at present in charge of Mr. Sanspere, who proved able and willing to give much valuable information on the surrounding country.

From this point the lake runs nearly due south-eastward for about thirty-five miles. Its width is greatly increased, and while its south-west shore shows little irregularity of outline, its north-eastern border forms two deep bays and is fringed by numerous islands. The shores continue on the whole low, though a rampart-like range of hills 800 to 900 feet in height runs along the north-east side, beyond the bottoms of the bays above referred to for eighteen or twenty miles from Na-tal-kuz. To the east of this is a low region through which a trail was at one time opened to Trembleur Lake, as a means of access to Omenica. At a little distance from the shore on both sides hills 700 to 800 feet in height appear as projections on the flat or undulating country of less elevation. There is as before much lightly-wooded and aspen-covered country, and if the climate is suitable, there is evidently here a wide stretch of land favourable in soil and contour for farming. The rainfall appears to become less as the lake is followed to the south-eastward. A few specimens of *Artemisia frigida* appear with the Douglas fir, and other plants not before observed.

Southern portion of lake.

Douglas fir.

At its upper end the lake turns to a south-south-east bearing and eventually for about twelve miles runs nearly due east. Its average width for twenty or twenty-five miles, is three and a half to four miles. It is evidently very deep, and the Indians say that this part of the lake does not freeze across in winter. With the appearance, of Tertiary volcanic rocks, which here occur tilted at various angles, the country becomes somewhat more rugged, and the land bordering the lake is higher. There are still, however, on the north shore some fine grassy slopes, while the south in more densely wooded.

Head of the lake.

A remarkably abrupt rocky hill of 600 to 700 feet high stands on the south side of the lake at its extremity. This is called Te-tzal-to. East of it is a wide low valley running to the south-east (S 55° E. 10 miles or more) from which a large stream flows. A small lake lies some way up it, according to Indian report, and a trail runs through to the Stella Indian village at the head of Fraser Lake.* A low tract,

Portage.

*See Report of Progress 1876-77, p. 46.

being the continuation of that in which the lakes lie, also leads through from the extremity of Babine Lake to Stuart Lake. The length of the portage, or actual distance over which goods have to be carried, is about seven and a half miles, and the Hudson Bay Company have constructed a moderately good waggon track between the lakes. The country passed over is undulating and appears to consist of wide terraced flats or benches, through which little rocky and gravely hills project. The summit is about 400 feet above Babine Lake, the valley some four miles wide between the steeper slopes, with a soil which though in some places good, is generally light. About one-third of the area may be regarded as suitable for agriculture. Most of the wood has been destroyed by fire, but the western scrub pine (*Pinus contorta*) appears to have been the most abundant tree. The portage trail ends at the mouth of a little sluggish river, less than one hundred feet wide, called the Yi-ko, which rises in a small lake to the north westward. The latitude of the point, at which the portage road ends at the mouth of the Yi-ko was found to be 55° 36′ 22″.

Yi-ko River.

Stuart Lake.

Stuart Lake or Na-kas-le, from the mouth of the Yi-ko south-eastward, is a fine sheet of water thirty-one miles in length, and about five miles in width in most places. Its north-western end is somewhat contracted and surrounded by mountains 1000 to 2000 feet high. It sends off a narrow arm or fiord in a north-westward direction, for a distance of probably ten miles or more, which distance might be added to the length as above stated. A short portage leads across from this arm to Trembleur Lake. The outline of the shore line about the north-western end of the lake is ragged, and there are many small islands, while to the east it runs in wide sweeping curves, and the water is evidently not so deep. Besides the Yi-ko, two streams of some size known as the Tache and Pinchi, flow into the lake. The first of these comes from Trembleur or Cross Lake, which in turn receives the water of Tacla Lake. It is by this route that goods are carried by the Hudson Bay Company from Fort St. James to their post on Bear or Connelly Lake in latitude 56° 6′. The Pinchi, also from the north, is smaller, and rises in a lake not many miles from Stuart Lake, and which appears to occupy a parallel valley. The peak Na-katl, 4800 feet in height, and its surrounding rugged limestone mountains, which touch on the north shore of the lake at its eastern extremity, have been described in former reports. The continuation of this range, running north-westward, altogether leaves the lake at the mouth of the Pinchi River. The land here becomes low and level, and is lightly wooded with aspen, mixed with coniferous trees. The south-western shore of the lake is pretty closely bordered by high hills, and as usual more densely wooded; but the

Tache and Pinchi Rivers.

Limestone range.

agregate area of cultivable land must be considerable. The Douglas fir is quite abundant round the shores of Stuart Lake, and I was informed on good authority, that it extends northward to near the middle of Tacla Lake.

CLIMATE OF THE LAKES.

Agriculture.

The northern or lower extremity of Babine Lake being more closely hemmed in by snow-clad mountains, is evidently less favourably situated than the remainder of this lake and Stuart Lake, and vegetation was found to be decidedly behind that of the Sus-kwa valley. Mr. Sanspere of the Hudson Bay Company, states that at the post at Na-tal-kuz, on Babine Lake, he can grow potatoes and many kinds of vegetables, and that his predecessor grew barley, which ripened well. An Indian living on the portage between the two lakes cultivates a little patch of land, and though very poorly attended to, he had a fine looking crop of potatoes and a little field of barley—the latter about three feet high and with the ear just appearing—at the date of our visit (July 4th). He also keeps some cattle here, cutting hay for them in swamps about the river mouth. At Fort St. James we found potatoes flourishing, but rather late, having been cut down by a frost in June. Barley was doing well, and has been grown as a regular crop for many years.* In the garden were peas, lettuce, beets, carrots, onions, garlic, turnips, cabbages and cauliflowers, doing well enough, but not carefully cultivated. Wheat has been sown this year as an experiment, and had not suffered from frost at the date of our visit (July 7th).

Temperature.

Temperature observations kept while on Babine and Stuart Lakes, —June 27th to July 8th—gave a mean minimum temperature of 40·2°. The mean of the early morning and evening observations being 51·5°. The temperature is here subject to greater and more rapid changes than in the Skeena valley, and on the night of June 29th we experienced a frost, the thermometer registering 26° near the northern end of Babine Lake, and in the vicinity of the snow-clad mountains already referred to.

Summer frosts.

In the valley of Babine and Stuart Lakes the summer season seems to be sufficiently long, and the absolute amount of heat great enough to bring all ordinary crops, including wheat, to maturity, but the question remains to what extent the liability to summer frosts may interfere with the cultivation of some plants, more especially wheat. Though this valley may be regarded as a continuation of the country of the Lower Nechacco, its vicinity to the mountains appears to render it somewhat inferior to that district in climate, and places it in this regard, in my opinion, nearly in the same position with the country

* Report of Progress Geol. Survey of Canada, 1876-77, p. 51.

bordering on François Lake. In previous reports,† I have described the flat country of the Lower Nechacco basin as constituting the greatest connected region susceptible of cultivation in the province of British Columbia. Its area has been estimated at 1000 square miles. It is based on fine white silty deposits of the later portion of the glacial period, constituting a soil almost uniformly fertile, and is remote from high snow-clad ranges. In the absence of further information, I can merely repeat what was said of this region on a former occasion, viz., that while it is not probable that wheat can be grown over all parts of its area, it can scarcely be doubted that barley may be ripened almost everywhere in it, while wheat would succeed in chosen spots. This region will, doubtless, at some time support a considerable population, but it is to be remarked that the passage of a railway through it would do little at present toward settling it; for in the first instance, the country to the east of the Rocky Mountains, in the Peace River or Saskatchewan valleys, would offer superior inducements to farmers and stock raisers.

Nechacco Basin.

INDIAN POPULATION OF NORTHERN BRITISH COLUMBIA.

Subdivisions of the Tinneh.

The Tinneh Indians of this northern part of the interior of British Columbia are divided by dialect into two great groups, known as the Porteurs or Carriers, and the Siccanies. The Carriers extend on the Fraser as far down as Soda Creek, near the mouth of the Chilcotin. They inhabit the valley of the Blackwater, and stretch westward to Gatcho Lake and the Coast Range, Fraser, Stuart, and Babine Lakes and the Watsonkwa valley; north of Fort St. James to Middle River, and east to Fort McLeod and the Fraser River, above Fort George to about 120° 30′ of longitude. The Siccanies lie to the north and east of the Carriers, occupying the west part of Tacla Lake and the region about Bear or Connelly Lake. They extend up the North Finlay about seventy-five miles and down the main stream of the Peace River to Hudson's Hope. North of the Siccanies and toward the coast, are the Na-ha-nies, who are said to speak a different dialect, while the Indians still further north, about Cassiar, are said to be again different.

Population of villages.

The *Na-taw-tĭn* or people of Babine Lake, number about 300. The *Na-kas-le-tĭn*, or people of Stuart Lake, are divided as follows:—Villages at Fort St. James, 75; at Pinchi River, 40; at Tache River, 32. At Grand Rapid, ten miles up the Tache, are the *Kus-chē-o-tin*, now numbering 22 souls; at Stony Creek, south of the Nechacco, are the *Ta-tshik-o-tĭn*, numbering 24; at Nool-ke Lake, the *Nool-kē-otĭn* numbering 56; of the *Nau-tle-a-tĭn* and *Stel-a-tĭn*, of Fraser Lake, I did not learn the number. There are no permanent villages on François Lake,

† Report of Progress Geol. Survey of Canada, 1876-77, p. 45. Canadian Pacific Railway Report, 1877. p. 252.

that part of the country belonging to the Watsonkwa people who visit it periodically.

STUART LAKE TO MCLEOD'S LAKE.

At Fort St. James we met the pack trains, which had been sent from Kamloops, and by means of which our supplies for the prosecution of the survey in the Peace River country were to be transported. We left Fort St. James on July 8th, the combined parties aggregating seventy-four pack and twenty-two riding animals, and reached Fort McLeod at the north end of McLeod's Lake on the 14th. This part of the route being the same with that traversed by Mr. Selwyn in 1875, and by Mr. J. Hunter in 1877*; and having already been described by them, need not be referred to here in great detail. The region as a whole is flat, and characterized rather by low ridges and terraces than by hills. Its eastern part drains toward Stuart Lake, but the greatest area is unwatered by the Salmon River and its tributaries, which flowing southward joins the Fraser near Fort George. East of the Salmon River lies the Pacific and Arctic, watershed beyond which the Long Lake River—a small stream—is found flowing toward McLeod's Lake. On leaving Stuart Lake the ground rises gradually till a height of 400 feet is gained at eight or nine miles from the Lake. The surface is generally undulating, has been frequently burnt over, and shows fine grassy meadows, suitable for cultivation. From this place to the crossing of Salmon River, the country consists of undulating uplands, the highest point of which is about 700 feet above Stuart Lake. Carrier Lake, two and a half miles long, is passed to the left, besides several other small ponds. These may occupy original inequalities in the surface of the drift deposits with which the surface is here heavily covered, the material being a sandy clay with stones and boulders like that called 'boulder-clay' elsewhere in British Columbia. At the east end of Carrier Lake, are some remarkable ridges which resemble moraines, but are composed of sand. The Salmon River is here a stream about fifty feet wide by two deep, with a gentle current. The latitude of the point at which the trail first touches it is 54° 36′ 26″. From Salmon River to Swamp River, so called, a sluggish tributary of the former, the distance is ten miles, the country resembling that above described, but being rather more broken and irregular, and quite useless agriculturally. Between Swamp River to the narrows of Lac a la Carp, or Carp Lake—twelve miles—the Pacific-Arctic watershed is crossed, with an elevation of 620 feet above Stuart Lake, or taking the latter at 2200 feet—2820 feet above the sea. The watershed region is characterized by the great

Reach Fort St. James.

Country east of Stuart Lake.

Carrier Lake.

Salmon River.

Carp Lake.

Pacific-Arctic watershed.

* Report of Progress, 1875-76, p. 34. Canadian Pacific Railway Report, 1878, p. 73.

spread of nearly level or slightly undulating terrace flats. These are generally sandy or gravelly, with occasional level ground occupied by swamps and small lakes. *Pinus contorta* is common, generally growing in a scattered manner, and rather stunted from the poor soil. *Lupinus polyphillus*, purple with blossom, was very abundant. Carp Lake has an elevation of 2747 feet. The trail crosses it at the narrows, and it is necessary to unpack and swim the animals. It would be easy to make a trail round the northern bay, which would avoid this trouble and the subsequent travelling in the water round the border of the lake. Carp Lake flows into Long Lake, a pretty little sheet of water with banks rising steeply to about one hundred feet, and a hill 500 or 600 feet high on the south side. Long Lake River, a small stream, is crossed by the trail at the lower end of the lake. Iroquois Creek, a small brook—so called from the murder of an Iroquois here by the Fort St. James Indians many years ago—is then crossed. Its valley is deep and to the south of the trail are large swampy meadows with fine feed. Beyond Iroquois Creek a series of mounds and ridges are passed over, and the trail then descends gradually, over dry sandy or gravelly slopes and terraces, which are for the most part covered with burnt woods, to the edge of McLeod's Lake. At the border of the lake the Long Lake River is again crossed at its mouth. It is here about fifty feet wide by two deep with a rapid current.

Long Lake.

Iroquois Lake.

The ridges several times referred to, are rather remarkable in character, and often strongly resemble moraines. Near the east end of Carp Lake are some peculiar depressions, in some instances nearly circular and over one hundred feet deep, occasionally holding pools. The surrounding country is a mass of ridges which however have no very constant direction, the whole being composed of gravel, or material like that above referred to as boulder clay. In the vicinity of Iroquois Creek these ridges are particularly noticeable and are associated with little terraces which generally seem to occupy lower levels and to have been later in date of formation.

Moraines.

The country between Stuart and McLeod's Lakes is thus somewhat higher than the Nechacco and Chilacco country to the south, and quite different in character, wanting the extensive deposits of white silt which there form a fertile soil. The soil is here generally light, sandy or gravelly, and is at present covered for the most part by burnt woods. A considerable area would doubtless be available for pasture land if the forest were completely removed by fire, and there are numerous swamps and meadows along streams yielding natural hay. The region cannot however be considered as of any agricultural value. It formerly yielded large number of skins, of marten, mink and other forest-inhabiting animals, but since the extensive spread of fires—some of the most

Region without agricultural value.

Forest fires.

important of which occurred about ten years ago—fur-bearing animals, with the exception of the bear, have been scarce. A frost was experienced on Iroquois Creek on the night of July 13th, my thermometer going down to 27°. No frost occurred however at Fort McLeod nine miles off and between four and five hundred feet lower.

The Douglas fir finds its eastern limit in this region near McLeod's Lake, and is not found on the lower part of the Parsnip. *Abies subalpina* is abundant in cold swampy spots on the route between Stuart and McLeod's Lakes. *Pachystima Myrsinites*, common on the Skeena, reappears in abundance in the vicinity of McLeod's Lake. On the dry land near Iroquois Creek the berries of *Shepherdia Canadensis* were beginning to redden and *Epilobuim angustifolium* to flower on July 12th. Vegetation.

McLeod's Lake and Misinchinca River.

McLeod's Lake is according to Mr. Selwyn sixteen or seventeen miles long, with an average breadth of about two miles. Its elevation by comparative readings is nearly that of Stuart Lake, or taking that of Stuart Lake at 2200, it may be stated as 2250. It lies in a north-north-west by south-south-east bearing, and may be regarded as marking at this place the line of junction of the interior plateau of the western part of British Columbia, with the western foot hills of the Rocky Mountain Range. From the higher undulating country to the west, a wide view embracing numerous rounded ridges to the eastward is obtained, and in the distance to the south-eastward mountains were seen bearing some snow in July. The immediate shores of the lake are bordered by low hills and ridges almost everywhere densely wooded. McLeod's Lake

The latitude of the Hudson Bay post, situated near the outlet of the lake at its northern extremity, was determined by Mr. Webster, who accompanied Mr. Selwyn in 1875, as 55° 0′ 7″. An observation by myself on the 15th of July last makes the latitude 55° 0′ 2″. In the garden at Fort McLeod we found at the date of our visit some ordinary vegetables growing well. The potatoes had been cut down by frost in June, but had recovered completely. The soil about the fort is, however, poor and little attention is paid to cultivation. D. W. Harmon, who resided in the northern part of British Columbia, or 'New Caledonia,' for some time—trading I believe for the North-West Company—in his 'Voyages and Travels' published at Andover, Mass., 1820, states that snow generally falls about Fort St. James and Fort McLeod about the 15th of November and is all gone about the 15th of May. The snowfall is said to be greater about McLeod's Lake than about Stuart Lake, reaching sometimes a depth of five feet, a fact confirmed Fort McLeod. Climate and snowfall.

by those now acquainted with the region. At Fort St. James the snow reaches a depth of about three feet.

Pack River.

The river issuing from McLeod's Lake, known as the Pack River, is from 150 to 200 feet wide, and had an average depth of about two feet in July last. It does not appear to be subject to heavy floods and carries clear brownish water derived from swamps and springs. It flows northward about fifteen miles to its junction with the Parsnip River, which joins it from the south-east. The tongue of land lying between the two rivers is mountainous opposite the end of McLeod's Lake, rising to a height of from 1500 to 2000 feet above the water. At about seven miles north of Fort McLeod these mountains end, and a plateau or terrace-flat with an average elevation of about 130 feet stretches from the expansion of the Pack River known as Lac la Truite or Tutia Lake across to the Parsnip near the mouth of the Misinchinca. The summit on this line is, according to Mr. J. Hunter, 250 feet above Lac la Truite. This flat country is sandy and gravely and not well adapted to agriculture. It falls northward toward the junction of the two rivers in a succession of benches of which some of the lower may be more fertile. The terrace-flat comes out on the bank of the Parsnip with its full height, and is found in scarped banks to be formed of gravel chiefly composed of quartzite fragments and covered over with fine yellow sandy soil. Evidence of increasing rainfall is found in the country to the east, as compared with that to the west of McLeod's Lake. The sandy and gravelly flats above referred to are characteristically clothed with the western scrub pine (*Pinus contorta*) but on the slopes and in valleys this tree is mingled with spruce (*Picea Engelanni* and *Abies subalpina*), aspen and birch; while the devil's club (*Echinopanax horrida*) again begins to abound.

Confluence of Pack and Parsnip Rivers.

Parsnip River.

The Parsnip River at the mouth of the Misinchinca is, according to comparative baramoter readings, 2170 feet above the sea. It has a width of 500 feet, and at the date of our visit (July 19) was full from bank to bank. The current is rapid, averaging probably three or four miles an hour, the waters being brownish and muddy and evidently in great part derived from melting snow. Above this place the Parsnip has not been explored since the date of Sir Alexander Mackenzie's visit, in June, 1793. He ascended the stream to its sources and portaged his canoe across to a small river running toward the Fraser. From his account it would appear that there are very high mountains about its head and probably true glaciers. This seems to be confirmed by the small possible drainage area of the river compared to the volume of water it carries. In the autumn, I was informed, the Parsnip is much reduced in size and meanders between wide gravel bars.

Sources unexplored.

The crossing of the Parsnip was accomplished on July 19th, the animals swimming the river without accident, while the *aparejos* and packs were ferried across in a boat which had been obtained from the Hudson Bay Company at Fort McLeod. The gentlemen connected with the railway survey then began their descent of the Parsnip and Peace Rivers, in the boat just mentioned, while I set out next morning by land for our rendezvous at Dunvegan, which proved to be at a distance of two hundred miles, and was not reached till the 16th of August. Mr. Joseph Hunter had in 1877 made a reconnoissance of the Pine River Pass for railway purposes, a short account of which is published in the Canadian Pacific Railway Report of 1878. Having penetrated eastward to about longitude 120° 30′, the season being far advanced and the country very difficult, he turned back by the way he had come. He had with him a small pack-train lightly loaded and did no more chopping than was absolutely necessary, travelling for many miles in the bed of the river. His trail was of some little service, but having now such a large number of animals, comprising Messrs. Cambie & McLeod's supply trains as well as my own, we were obliged to do much work in chopping, brushing swamps, and bridging streams along all parts of the route.

Cross the Parsnip and set out for Dunvegan.

Mr. Hunter's exploration.

The country on the east bank of the Parsnip is all densely wooded or covered with windfall or *brulé*. The surface rises gradually, or in a succession of low steps for a distance of six to eight miles, when mountains 1500 to 2000 feet in height above the river appear. Following the south bank of the Misinchinca we passed over sandy and gravelly benches which are generally less than 100 feet above the stream and are covered with western scrub pine of small size. The undergrowth includes a small blue-berry a *Houstonia* and frequent patches of grey or white moss. Though the extent of flat land about the mouth of the Misinchinca and bordering this part of the Parsnip is considerable, it is scarcely to be regarded as of any agricultural value. The Misinchinca River is tortuous and not very rapid, with swampy flats covered with black spruce and other moisture-loving plants on the inner sides of its bends, while the opposite bank is usually formed by the scarped edge of a gravelly terrace, of which the stones are glossy schists and quartzites.

Country at mouth of Misinchinca.

At ten or twelve miles up the Misinchinca the terraces above described come to an end, and the mountains which now bound the valley continuously, slope down on each side of the river-flat. The flats have generally a width of about a mile and the river flows through them with a very crooked course. The luxuriant growth of devil's club, ferns, moss and lycopodium indicate a humid climate. Willows and tall dark groves of spruce immediately border the river.

Misinchinca River.

Misinchinca Crossing. Following Mr. Hunter's example, we crossed the Misinchinca about eighteen miles from its mouth in latitude 55° 14′ 39″, as the river here touches the hills on the left of the valley, and the slopes being rugged and thickly tree-clad present great difficulty to travel with loaded mules.

Upper Misinchinca. Eight miles above the crossing, the Atunatche stream joins the Misinchinca, which is here found coming from the south-eastward, while a massive range of limestone mountains, attaining elevations of from 5000 to 6000 feet above the sea, appear to block further passage to the north-eastward. From the crossing to the mouth of the Atunatche the Misinchinca valley continues as a flat-bottomed trough never less than eight-tenths of a mile in width. The river is very crooked and though much obstructed with drift-wood is not very rapid till within about two miles of the Atunatche. It then changes its character, flowing swiftly over coarse gravel and boulders and spreading widely in seasons of flood through 'sloughs' and alternative channels by which the valley bottom is cut up. Most of the land in the bottom of the valley is elevated only a few feet above the river and some of it is evidently liable to overflow. The mountains at the sides of the valley rise boldly to heights of 2500 or 3000 feet above it in some instances, and are densely tree-clad with the exception of the highest points. Large trees of black spruce and cottonwood occur in some places, several of the latter being observed to attain five feet in diameter. The vegetation **Vegetation.** continues to assume a more alpine character, the undergrowth including *Veratrum album*, *Lonicera involucrata*, devil's club, alder, elder and various ferns.

The elevation of the mouth of the Atunatche is 2500 feet.

THE PINE PASS AND PINE RIVER.

North-west and South-east valley. The valley which is occupied by the lower part of the Misinchinca may be said to come to an end at the mouth of the Atunatche, inosculating with a second which runs in a north-north-west by south-south-east course parallel to the main direction of flexure and elevation in this part of the Rocky Mountains. It marks in a general way the junction of the schistose and slaty beds so far met with, with the massive limestones of the axis of the mountains which appear to underlie them. To the south-south-eastward this valley is occupied by the main stream of the Misinchinca, and was followed up for twenty-six miles by Mr. Hunter, who found it to end finally among high limestone mountains. In the opposite direction this depression becomes the Atunatche valley and further on that of the upper part of the Pine River, which after flowing north-north-westward for eleven miles, turns abruptly to the eastward and finds its way to the Peace River below Fort St. John. In

Plate 2.

G. M. D., Photo. July 27, 1879.

SUMMIT LAKE AND LIMESTONE MOUNTAINS, PINE PASS.

travelling northward across the summit one has the high axial limestone mountains already referred to on the right hand with lower and more rounded mountains to the left. The limestone mountains form a regular wall-like range, the higher summits of which probably reach 6000 feet and still held considerable patches of snow in shady hollows, near the end of July. **Limestone mountains.**

From the mouth of the Atunatche to the lower end of Azouzetta or Summit Lake, a distance of three and three-quarter miles, the valley probably averages half a mile in width of flat ground or gentle slopes, with the exception of about half a mile near the mouth of the Atunatche where it becomes somewhat contracted, with steeply sloping side-hills. Mr. Hunter states the rise of the valley in this distance to be 270 feet while by my barometer on July 27th it appeared to be about 350, and this I believe to be nearly correct. **Atunatche Valley.**

Azouzetta Lake is about a mile and a third in length and probably three-quarters of a mile wide in some places. It is evidently shallow and holds one or two little wooded islets. Its south end is bounded by a low grassy flat. The lake drains into the Atunatche, but about three-fourths of a mile beyond its north-western or upper end a stream forming the source of Pine River is found entering the valley from the mountains on its south-west side. This on the 28th of July was estimated to average twenty-five feet in width by six inches deep, with a rapid current. The space between the elbow which this stream makes in turning from its first course into that of the valley, and the head of Azouzetta Lake, is occupied by a series of swamps and beaver ponds with groves of thick and tangled spruce. This forms the actual watershed which is so low and undefined that it is probable water may run in both directions when the country is wet. In the detritus carried into the trough-like valley by the source of Pine River and other little streams, the cause of the actual position of the watershed is probably to be found. **Summit or Azouzetta Lake.** **Watershed in the Pass.**

The latitude of our camp at the summit, opposite the bend of the stream forming the source of Pine River, above referred to, was 55° 24′ 17″ by observation. **Latitude.**

Before leaving Stuart Lake we had arranged with Mr. Alexander, in charge of the Hudson Bay post there, to keep a record of the state of the barometer, for the purpose of comparison with observations to be taken on our way eastward. The readings kept by Mr. Alexander do not, however, show a very close correspondence with fluctuations observed by us, and were generally taken at intervals of some hours from our observations. By comparison with Mr. Alexander's readings, the height of the summit of Pine Pass is 2795 feet. I have subsequently obtained from Mr. Horetzky a copy of his barometer observa- **Heights determined barometrically.**

tions on Babine Lake, and by comparison with these, believe the true height of the pass to be 2850 feet, very nearly.

Great bend in Pine River.

From the upper end of Azouzetta or Summit Lake, the valley runs north-westward about eleven miles, then northward for two and a half miles, and next turning nearly due east, continues in that direction for about nine miles. In thus following the Pine River from its source for a distance of over twenty miles, the actual distance gained from Azouzetta Lake and the summit, in a northerly direction, is about seven and a half miles only. The mountains included in this loop may be regarded as a part of the axis of the range, but decline in elevation north-westward from the vicinity of the summit to the bend of the river.

"The Precipice."

Two miles from the head of Azouzetta Lake, a sudden drop in the level of the bottom of the valley occurs, being that which Mr. Hunter refers to in his report as "the precipice." This is produced by the outcropping edge of a bed of limestone which here runs across the valley. The abrupt portion, which may be called a cliff, though never forming a sheer precipice, and generally more or less densely covered with trees, moss and bushes, with piles of fallen rock here and there, has a height of 130 feet above the flat bottom of the valley below it. The brook forming the source of Pine River follows the left or south-west side of the valley, descending through a little rocky gorge. The total descent from the summit of the pass to the flat at the base of the precipice, is about 158 feet, and this occurs in a distance of about a mile and a quarter.

View from "the Precipice."

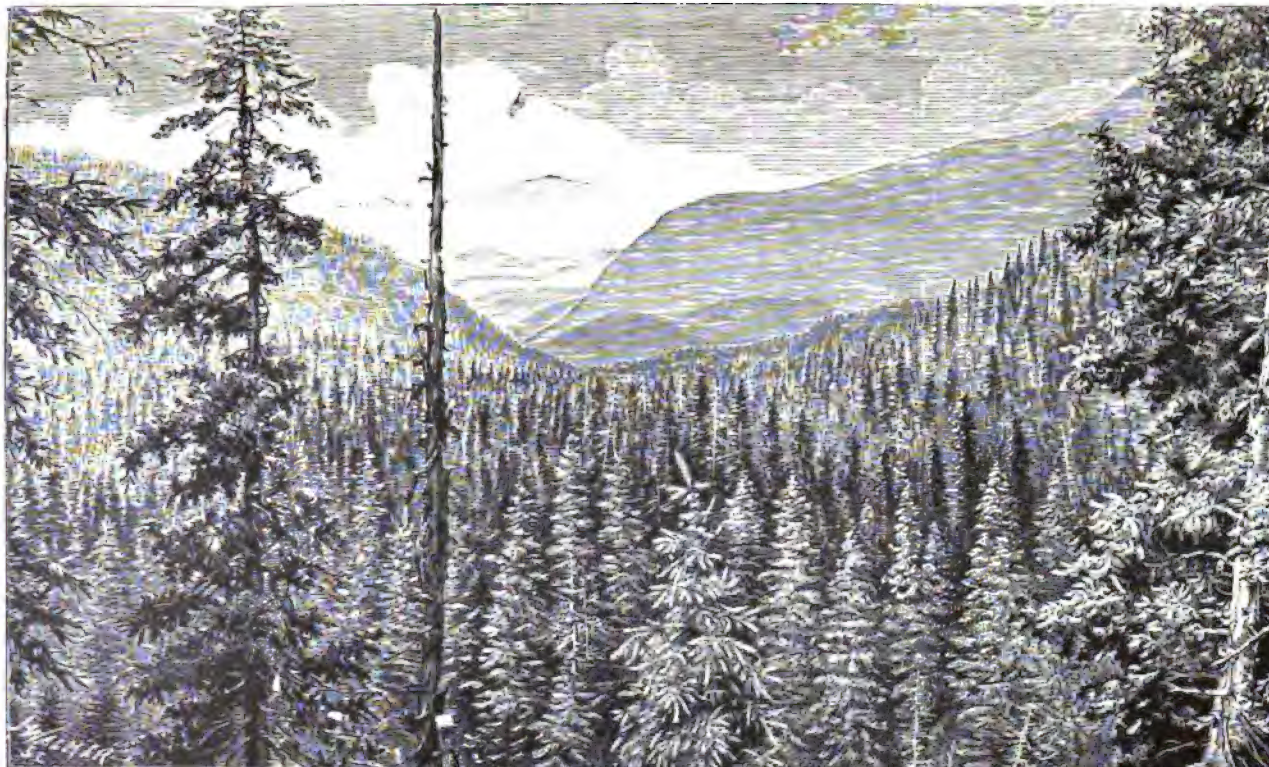
From the precipice a fine view down the valley is obtained. To the right are limestone peaks probably rising 3000 feet above the stream, while on the left the mountains are much lower and more rounded. The slopes on both sides are gentle towards the bottom of the valley, and the hill sides do not appear to be much broken up by ravines or gullies, and little rock is seen except at a considerable height on the slopes. The bottom of the valley appears narrow, but on travelling down it, it is found to be straight, with either flats or very light slopes continuously bordering the stream. Its average width is probably about a quarter of a mile. The total fall of the stream in a distance of about five and a half miles from the summit, including that part of the valley in which the precipice occurs, is about 207 feet. The valley is densely wooded, and occasional groves show large and fine trees. *Aconitum Napellus* was observed to be abundant and in full flower.

Fall of the stream.

Pine River Valley.

At the end of the north-western reach of the valley it has an average width of about half a mile, which it maintains with considerable uniformity for a distance of about eleven miles, or to the end of its eastern reach above referred to, where, opposite Canoe Mountain, it becomes

Plate 3.



G. M. D., Photo. July 28, 1879.

LOOKING DOWN UPPER PINE RIVER VALLEY FROM "THE PRECIPICE."

somewhat contracted, though probably in no place less than a quarter of a mile wide in the bottom. The valley is generally flat-bottomed, most of the flats being elevated but a few feet above the river. The slopes at the base of the hills are also as a rule light, and on the right bank no rocky bluffs project to the river. The river pursues a tortuous course, running over beds of flat pebbles of clean, silvery schist, with a current uniformly swift, but without any waterfalls or heavy rapids. Three tributary brooks were observed to join the main stream from the south-west and west, between the summit and a point about thirteen miles down the valley. At fifteen miles from the summit, a tributary about half the size of the main stream, and estimated to average forty feet wide by six inches deep, enters from a wide valley which runs north-westward, and may be considered as forming the continuation of the main valley previously defined. Tributary streams.

Below Canoe Mountain the river turns to a north-eastward course, and the older rocks characterizing the country from Fort McLeod to this place are replaced by Cretaceous sandstones. Canoe Mountain.

Agriculturally, the country passed over from Fort McLeod to this point is of very little value, for though there are limited areas susceptible of cultivation, they are quite insignificant as compared with the fertile regions to the eastward, and have probably an inferior climate.

The valley of the Misinchinca appears to be well adapted for railway construction as far as the mouth of the Atunatchi. Assuming the rise from this point to the summit to be 400 feet (which is probably a maximum,) the distance between the two points being about five miles only, it would probably be necessary to gain grade on the hillside forming the north bank of the Misinchinca. The hillside appears to be not unfavorable to this for a distance of about three miles below the Atunatchi, which would give a total distance of eight miles in which to overcome the ascent. The work would probably be moderately heavy throughout. In crossing the summit, a line should follow the south-west side of the valley, as the slopes there are light and not rocky. On the opposite side of the valley, the mountains being higher and for the most part bare, several "fans" of *débris* occur, and there are also evidences of small snow-slides in winter. The descent from the precipice on the opposite side of the summit would also require to be accomplished on the south-west side of the valley, where the slopes are moderately light and regular. The bottom of the valley once gained, no further difficulty would be encountered, with the exception of probable crossings of the stream to avoid curvature. Character of the Pass.

For about sixteen miles from Canoe Mountain the valley takes a direct north-eastward course, and at this distance may be said to leave the eastern foot-hills of the Rocky Mountains and to enter the plateau Valley below Canoe Mountain.

country. Near Canoe Mountain several summits rise to heights of 2000 to 3000 feet above the valley, but the mountains gradually decrease in elevation from that point, and at the edge of the foot-hills seldom reach a height of much more than 1000 feet. The rocks are chiefly sandstones, and from a much disturbed condition gradually become less and less sharply folded, till at the point above indicated as the edge of the foot-hills, they are horizontal or very nearly so. The width of the flat bottom of the valley averages half a mile till near the edge of the foot-hills, when it expands to about a mile. Gravelly benches forty to fifty feet high are occasionally seen, and considerable areas of the bottom of the valley are cultivable, though the hills at the sides are almost without soil, and show, even at a distance, the flexures of the sandstone rocks composing them. The climate changes in this part of the course of the river from the extreme humidity characteristic of the mountains, becoming much drier and warmer. In consequence of this, most of the river flats have been burnt over, and some are almost completely cleared by fire. Raspberries were abundant and ripe in such places on the 1st of August. The river appears when in flood to rise about five feet above its summer level in the upper part of this reach. Near the border of the foot-hills the floods rise about eight feet above the summer level; while the river at the time of our visit averaged about one hundred and seventy-five feet wide.

Change in climate.

River floods.

Valley and plateau.

The valley next runs a few degrees south of east for about seven miles, and then resumes its north-eastward course for sixteen miles. The average width of the valley is fully a mile in this part of its course, and in some places it may reach two miles. The plateau level is about 1000 feet above the valley bottom and generally presents serried ranks of dry whitened trees through which fire has passed once. In the first eight miles of this part of the valley terraces constitute a particularly prominent feature, rising generally about 100 feet above the river, and being composed of gravel, fine sand or silt. A railway line would probably require to cross the river two or three times in this part of its course, as more or less degraded terraces occupy some of the bends which it makes in the valley. Horizontal beds of sandstone outcrop frequently in the hillsides. A large portion of the bottom of the valley has been cleared by fire and is very fertile with a natural growth of pea-vine and grass as high as a horse's back. The northern bank of the valley is generally open and grassy and the dry character of the climate is evidenced by the occurrence of sage (*Artemisia frigida*) and *Eleagnus argentea*. Choke cherries, and the small wild red cherry were noticed here for the first time, and the service berries were found to be ripe on the 3rd of August.

Dry climate.

One considerable tributary joins the Pine River in this part of its course. It comes from the south-westward and must drain the country between the main stream of Pine River which we have followed down and the Sukunka or Middle Branch. It has projected a large 'fan' into the valley at its entrance, forcing the river over to the north side. **Tributary stream.**

From the point to which the description of Pine River valley has now been carried, the stream turns abruptly, and running south-south-eastward for four miles joins the Sukunka. A wide trough-like valley, forming the continuation of that which Pine River has so far followed, runs on in a north-eastward direction and may be followed across to the Pine River below the Lower Forks. Near Pine River it is about two miles in width and it becomes wider and more diffuse, the hills at the sides decreasing in height, and the bottom sloping up gradually At the river it is floored by benches from 100 to 200 feet high, and from it flows a small tortuous stream. **Wide lateral valley.**

The part of the river above described as flowing south-south-eastward to join the Sukunka, occupies a valley which seems to be later in origin than that of the upper part of the stream. It is comparatively narrow, averaging probably about a mile between the bases of the steep slopes. Its bottom is chiefly formed by terraces of silt 100 to 200 feet above the river, and is broken by many and deep transverse gullies. The river is somewhat tortuous, and owing to the fact that the scarped fronts of the terraces come out to the bank, it would probably be necessary to cross it two or three times with a railway line. Its width is from 150 to 200 feet. The length involving rather heavy work on this part of the line is about two and a-half miles. **Narrow valley.**

A very fine view up the valley of the Sukunka or Middle Branch may be obtained from the edge of the plateau above the valley at the the fork. The valley of the Sukunka is an important one, quite equal in size to that of the main stream above the constricted portion just described, and generally resembling it. The river pursues a devious course bordered by wide flats and occasional gently sloping 'fans' projecting from the sides of the valley, which are sometimes bare but are generally covered with thickets of young aspen and pine which have grown up after fire. The valley runs in a direction a few degrees west of south for about ten miles, when it appears to turn more to the east. Its average width exceeds a mile, and there is thus probably at least ten square miles of fertile land in sight in this part of its length, with grazing grounds on the slopes and hills above which might be greatly improved and extended by burning off the woods more completely. **Sukunka or Middle Branch.**

At a distance of twenty or thirty miles off to the southward some

Snowy mountains.

mountains were seen, with small patches of snow still (August 5) clinging to them; but no bare and rugged peaks like those forming the axial range of the Rocky Mountains were in sight. A flat with an area of probably 1000 acres occurs at the fork. It is in part sandy and gravelly, but shows also wide meadows covered with luxuriant herbage forming fine pasturage for animals.

Plateau at Middle Forks.

The plateau above the river valley is here partly open but generally covered with young pine and aspen, or with burnt forest not yet replaced by new growth. Much good summer grazing land exists but the surface is probably not adapted to agriculture. The general character of this part of the country is that of a high broken plateau traversed by wide generally trough-like valleys rising to a hilly or even mountainous region toward the main range. The land in the valleys appears generally to be well suited for cultivation, while the slopes and summit of the plateau will constitute good stock ranges.

Latitude and height.

The Middle Branch appears to be about equal in volume to the main stream. The latitude of our camp on the flat above referred to was found to be 55° 37′ 23″, making the approximate latitude of the actual confluence of the rivers 55° 36′ 23″. The Pine River at the Forks is 624 feet above the level of the Peace River at Dunvegan or about 1930 feet above the sea.*

Valley below Middle Forks.

From this point the river turns again to a north-eastward course nearly parallel with the direction of its upper portion, and in eighteen miles reaches its confluence with the East Branch. For eleven miles the valley is open, though probably averaging less than a mile in width. Terraces extend several hundred feet up the sides of the valley, but are difficult to identify in many cases owing to the outcrop of horizontal beds of sandstone. Extensive slides have also occurred, producing in some places sharp ridges parallel to the sides of the valley. These are all, however, of old date and now show no signs of motion. The valley is also somewhat cut up by 'sloughs' and the terraces occasionally front directly on the river, but there is still a considerable proportion of fertile land. The river now enters a contracted part of its course which has been called the Cañon. It is about three miles in length, and for this distance the sandstones and shales form steep slopes or cliffs rising from the water's edge on both sides, generally to a height of about 100 feet above the river. Above this the heavy drift deposits form slopes for several hundred feet higher, reaching eventually the level of the plateau at about 500 feet above the river or 2350 above the sea. The slopes are as a rule steep but generally not so much so

Canon.

* The height of this point and those assigned to other places between this and Dunvegan, are checked by barometer readings at the latter place by the Rev. D. M. Gordon, and are probably close approximations to the truth. The height of Dunvegan is estimated at 1305 feet.

as to prevent their being covered with grass. They are very irregular, being broken by ravines and gullies. It would probably be necessary to cross the river several times in the cañon with a railway line, and there would be some heavy rock cutting.

Valley below canon.

Below the cañon the valley again expands, and in four miles reaches the Lower Forks. It is not, however, so wide as that either of the Sukunka or upper part of the main stream, being contracted by terraces at the sides. The high plateau now no longer exists, but the country is based on a heavy covering of drift deposits which spreads widely at a height of about 500 feet above the river, forming a very fertile soil. From high points the view to the northward is sea-like and unlimited, while southward the broken hilly plateau before described begins to rise irregularly. The plateau has at one time been heavily wooded, but has now in most places been traversed by successive fires, which have not only destroyed the forest but consumed the greater part of the fallen logs, producing prairie country with patches of young aspen in the vicinity of the river valleys. The lower terraces on this part of Pine River, and about the Lower Forks produce a wonderfully luxurient growth of pea-vine and grass, and plants common on prairie land begin to appear.

Plateau.

Lower Forks.

The latitude of the confluence of the rivers at the Lower Forks was found to be 55° 43′ 42″. The East Branch is the larger stream, its volume being in proportion to that of the branch we have followed down about three to two. The water of the East Branch is more heavily charged with silt and has somewhat the appearance of a stream fed by glacier water. Both rivers are rapid and not deep, though it was with some difficulty and not without risk that we forded the East Branch on August 7th.

At the Lower Forks of Pine River the mountains and high level plateau country has been left behind, and instead of finding fertile land in small and isolated patches the general surface of the country becomes susceptible of cultivation, the barren tracts being exceptional.

Table Mountain.

Table Mountain ascended by Mr. Selwyn in 1875,* and in 1877 by Mr. Hunter,† is situated about half way between the Lower and Middle Forks of Pine River and forms one of the outliers of the higher plateau, of which others occur to the southward east of the Sukunka. Its elevation according to Mr. Selwyn is 3400 feet, according to Mr. Hunter 3500 feet.

Pine Pass as a railway route.

The character of the Pine Pass in regard to railway construction appears to be very favourable, but as Messrs. J. Hunter and H. J.

* Report of Progress 1875-76, p. 54.

† Canadian Pacific Railway Report 1878, p. 79.

Cambie have both given special attention to this point,* it is not necessary to enter into detail here. An independent estimate by myself gave, however, the following results:—

Total distance by the river valley, which a railway line would have to follow, from the Parsnip at the mouth of the Misinchinca to the Lower Forks of Pine River, 108½ miles.

Distance on a straight line bearing N. 50·5° E., 81 miles.

Of the distance by the valley 93 miles may be classed as easy work, 2½ miles as moderately heavy work, and 13 miles as heavy work.

The Rocky Mountains.

The Rocky Mountain Range where crossed by the Pine Pass may be said to be nearly forty miles wide, but this includes a considerable width of foot hills on each side, the high and rugged summits forming a comparatively narrow zone, and apparently not rising above 6000 feet in height. In following the chain southward and eastward to the 49th parallel, the passes generally increase in height and the mountains reach a greater altitude and show grander and more rugged outlines. Near the 49th parallel, again, the eastern side of the mountains is abrupt and well marked, while in the region now described the mountains fall gradually to hills, which are reduced eventually, and without any well marked line, to the level of the plateau. A comparison of the geological features of the mountains on the Pine and Peace Rivers with that of those to the south-eastward, is made on a subsequent page. To the north of the Peace River, we as yet know hardly anything of the range.

Country generally wooded.

From Fort McLeod to the Lower Forks the country may be descibed as a whole, as densely wooded, the only exceptions being the summits of mountains too high or too rugged to bear forest, or such places as have been cleared by fires.

Vegetation and climate.

From the mouth of the Misinchinca to a point on Pine River about seven miles north-eastward from the highest point of the range, there is evidence in the vegetation and otherwise of a humid climate, and forest fires have been few and have not affected great areas. The valleys are here filled with dense dark groves of spruce in which the trees often obtain a great size, while the hillsides are also clad with coniferous forest, becoming more and more stunted toward the summits. From the point above mentioned eastward, fires have been frequent, and along the south bank and on the flats of the river valley grassy meadows begin to appear. Ten miles above the Middle Fork *Artemisia frigida* and *Eleagnus argentea,* with the wild red cherry and choke-cherry were for the first time observed. Service-berries (*Amalanchier*) were here found ripe on the 3rd of August. Before reaching the Lower

* Canadian Pacific Railway Reports 1878, p. 72, 1880, p. 52.

Forks, sunny slopes showed such flowers as *Monarda fistulosa*, *Campanula rotundifolia* and *Anemone patens* which are found very generally distributed over the prairies of the North-west. Raspberries were found ripe in the upper part of Pine River, and the berries of the viburnum turning red on the 31st of July.

Difficulties of travel. Owing to the densely wooded character of the country and the number of swamps, streams and other impediments to the passage of the animals, it was not without putting forth every effort that we were able to make an average actual advance of about five and a half miles a day from the Parsnip to the Lower Forks. On Pine River we found it advisable to follow Mr. Hunter's example and travel for the most part in the river bed, crossing and recrossing to keep shallow water and firm bottom. During this part of the journey several of us were constantly employed in advance on horseback searching for fords and marking them with bushes, or cutting trail across wooded points which it was impossible to go round in the river. The country was evidently comparatively dry at the time we passed, and in the spring it would be quite impossible to bring a loaded pack train through by this route without expending a great amount of labour in trail-making.

Game and Indians. Game must be very abundant in some parts of the mountains, particularly the moose, bear end beaver. We found many of the bars and mud banks along the rivers from which the water had not long receded quite covered with the tracks of these animals. The Siccanie Indians of the vicinity of Fort McLeod travel eastward up the Misinchinca, but apparently visit it very seldom, as there is no well-marked Indian trail. Near the Summit Lake we found traces of an Indian camp a few years old, and we were informed that a trail of some sort leads to this place from the Parsnip west of the Misinchinca valley. From the east the Beaver Indians hunt westward toward the sources of the Pine River, but owing to the difficulty of travel caused by the burnt forest and windfall, have nearly abandoned the head waters of the streams. **Head of canoeing.** We found, however, a small cottonwood canoe cached on the Pine River opposite the summit which I have named Canoe Mountain, and not far from the eastern base of the axial range of the mountains. From the appearance of branches which had been thrown into the canoe it must have been left here in the preceding May, when the river was probably very high. **Height of flood.** On this part of the river there is evidence of the rise of the water in floods to a height of five feet above its low water level. Half way from the summit to the Middle Forks an extreme rise of eight feet is indicated.

Observed temperatures. In regard to climate, the route from Fort McLeod to the Middle Forks of Pine River, seventy-two miles distant, may be treated together

as representing the Rocky Mountain zone, including the foot hills of both slopes and the higher plateau attaching to these on the north-eastward. From July 17th to August 5th, the mean of the observed minima on this part of the route is 39·7°. The mean of the early morning and evening readings of the thermometer, 49·4°. This must be much below the actual mean temperature, for the thermometer had seldom risen much above its minimum when observed at 6 a.m. The heat was sometimes great in the middle of the day, but as we were then always travelling, could not be registered. Three frosts were experienced, on the nights of the 2nd, 3rd and 4th of August, the thermometer reading 30·5°, 28° and 30·5° on these nights respectively. Strong westerly winds, falling calm at sundown, with a clear sky, were the conditions causing the frosts.

Lower Forks of Pine River to Dunvegan.

Limits of country described.

The portion of the Peace River basin for which the exploration of 1879 enables pretty accurate general information to be given, may be considered as extending eastward from the Middle Forks of Pine River. West of this point, as already stated, the areas of fertile land are small, being confined to certain river valleys which penetrate the foot hills of the Rocky Mountains, and the high plateau attached to them. With this western limit, the region now to be described may be defined as bounded to the north by the 57th parallel to its intersection eastward with the Peace River. Thence the boundary may be assumed to follow the Peace River southward to the mouth of Heart Brook, near the confluence of the Smoky River. Thence to run south-eastward to the extremity of Lesser Slave Lake, to follow the western border of the hilly region lying to the south of the lake to the Athabasca River; thence to follow the Athabasca westward to the foot hills, and skirting the foot hills to run north-westward to the first mentioned point on Pine River.

Area and mode of description.

The tract included within the limits above given has an area of about 31,550 square miles, and by far the largest part of this area may be classed as fertile. In treating of this region a description of the routes followed will first be given, embracing such details as are likely to be of value. This will then be succeeded by such general deductions as to physical geography and climate of the district as our knowledge will allow. The region as above defined being somewhat homogeneous it is possible to arrive at the general facts in regard to it with some degree of certainty.

No news at Lower Forks.

It had been arranged that Mr. MacLeod, in event of his arriving in time at Dunvegan, should carry his exploration for railway purposes

westward to the Pine River Forks, and leave there a note stating his whereabouts and telling me what he wished done with his contingent of the pack train. On arriving at the Forks on August 7th no such note could be found, and the flats along the river side though covered with a luxuriant growth of wild pea and vetch, showed no tracks of men or horses, though here and there trodden down in devious paths made by the bears in feeding. We fired a number of shots in the calm of the evening to bring in any Indians who might be in the vicinity, but without success, and so the next morning, after having put up a notice of our visit, we set out for Dunvegan. The neighbourhood of the Forks presents many features of geological interest, but the season was already so far advanced and the time to be occupied on the way eastward so uncertain, that I did not feel warranted in delaying there a day.

Coal Brook.

We followed for a few miles the north bank of the East Branch of Pine River, travelling along open or lightly wooded flats, and then turned northward up the valley of a small tributary called by Mr. Hunter, Coal Brook.* The stream at this date was about thirty feet wide by six inches deep, with a slope of about one in one hundred. In flood it must be from seventy to a hundred feet wide. For about five miles the valley is narrow and gorge like, and very tortuous, with banks of sliding Cretaceous shales and sandstones forming scarped hillsides 200 to 300 feet high where the brook impinges upon them. At the distance from its mouth above indicated, the valley widens to about a quarter of a mile, with flats bordering the stream on the right and left sides alternately. The sides of the valley still continue steep, though decreasing in height. We travelled chiefly in the bed of the brook, or along the low flats bordering it, and camped in the evening at about fourteen miles from the Forks, at an elevation of 2150 feet or 300 feet above the Forks.

Country between Coal Brook and Buffalo Creek.

From this camp to the next—a distance of about thirteen miles—we travelled in the first instance up the bed of the stream, as before. The banks becoming gradually lower, and showing gravelly and bouldery drift deposits with occasionally a few feet of the underlying Cretaceous shales. We then found, not without some difficulty, the point at which Mr. Hunter had left the brook, and by keeping three or four of our Indians constantly ahead looking for signs were able to follow his old marks to the summit between Coal and Buffalo Creeks. Our camp at this point was at an elevation of 3300 feet and the country somewhat hilly, being in fact a broad ridge very much higher than most of of the region. The woods are composed of black spruce, scrub pine,

* This must not be confounded with 'Coal Creek', of Mr. Selwyn's report, which is a small gorge on the south of Pine River Canon.

birch, aspen, cottonwood and alder, in most places dense, but where fires have passed grass is found growing luxuriently. The soil is good being a pale silt.

Buffalo Creek Valley.

August 10*th*.—Leave camp early and travel till 4 p.m., passing at first for some miles through heavily wooded country, but on coming down to the sources of Buffalo Creek find a more open region, with considerable areas of scattered aspen groves and grassy flats, which continue to become more extensive as we descend the stream. The valley when first seen is small with gently sloping sides, but continues widening, till at our evening camp it is nearly a mile in width. The plateau at the sides at the same time becomes lower, and the rounded hills which rose above the level of the upper terrace or plateau on the upper part of the stream disappear. The soil is everywhere fertile and susceptible of cultivation, and earthy drift or loam twenty to thirty feet deep is exposed in banks near our evening camp, which is situated a few miles above the junction of Buffalo Creek and Mud River. Found some recent horse tracks and signs that the valley has been visited by Indians within a few weeks. Near this point Mr. Hunter, in 1877, turned back after getting into a tangled and swampy country on the east side of the Mud River. Determined to keep a few miles further north to avoid this known bad country and then set out on a compass course for Dunvegan.

Indian signs.

Cross Mud River.

August 11*th*.—Travelled about ten miles eastward, keeping on later than we otherwise would have done on account of the difficulty of finding water. Two miles from morning camp cross Mud River, now averaging 120 feet wide, with a moderate current and muddy banks. It is depressed fifty feet below the level of the wide valley which it follows to the northward. To the north-eastward the country is evidently a nearly level plateau which appears however to fall gradually to the north. To the south are low hills which seem to rise about 300 feet above the plateau. The valley of Mud River is in great part open, well grassed and with very fertile soil. As it appeared to turn too much to the northward and westward, we ascended its east side to the level of the plateau. This has been originally more or less heavily timbered with black spruce, scrub pine, cottonwood and aspen often of fine growth. Fires have, however, swept over considerable districts which are now covered with second-growth aspen or fallen timber. Our camp, which is at about the average level of this part of the plateau, is at an elevation of 2600 feet. The latitude, determined by a meridian altitude of Altair 55° 46′ 54″.

Plateau east of Mud River.

Heavy windfall.

August 12*th*.—Cut our way with much labour for some miles through heavy windfall among which young aspen groves are struggling up, but get before long into standing woods and eventually into

open groves through which we travel along easily, till catching a glimpse of a still more open country to the northward we turn in that direction and emerge on a valley with gently sloping sides, one to two miles wide and chiefly prairie with coppice of willow and alder bushes here and there. This is the first prairie country we have seen and contrasts very pleasantly with the dense forests through which for the most part we have heretofore been groping our way. The grass is in some places as high as the horses' bellies and is already ripe and turning brown at the tops. The hillsides are gay with summer flowers such as Castilleia, Aster, and Solidago. After travelling a few miles through this park-like country we caught sight of a couple of Indians, who immediately plunged into a thicket, evidently much alarmed, and were next seen on the top of a hill about half a mile off running away as fast as they could. The invasion of this quiet region by a party so large and so unfamiliar in style of equipment, is doubtless enough to disturb the equanimity of a timid Beaver Indian, who has perhaps never even seen mules before. Camped on the bank of a small river which flows northward in a valley about 200 feet deep, traced in the bottom of a much wider hollow.

Pouce Coupée Prairie.

See Indians.

This stream we found afterwards is known where it reaches the Peace River as the D'Echafaud, the country about it being called the Pouce Coupée Prairie. The valleys here are not mere troughs cut in the plateau, but wide depressions with gentle slopes, and at times a trough-like course in the bottom. The plateau itself is usually a widely extended terrace level. The soil in the valleys is very deep and rich, while that of the plateau is similar but not so deep, and rests on a silty deposit, which when it comes to the surface gives the soil a pale aspect. Even the silt, however, is a rich soil as evidenced by the luxuriant growth found upon it. Service berries were abundant but over-ripe in sunny spots at the date above given. Choke cherries beginning to ripen.

D'Echafaud River valley.

Soil and climate.

Two of the men who had pursued the runaway Indians to their camp, returned shortly after we had camped, and were followed by a number of men, women and children curious and hungry. These were the first people we had seen besides our own party since leaving the Parsnip River twenty-four days previously. They are Beavers, a tribe of the Tinneh stock, but differing considerably in language from their relatives on the west side of the mountains. An Indian from Stuart Lake whom we had with us was able to understand their language imperfectly, while it was almost unintelligible to a lad from the vicinity of the Skeena Forks. The Carriers near Skeena Forks approximate in their coarse features and broad faces to the Indians of the coast. This resemblance becomes less marked about Stuart and Fraser Lakes, while

The Beaver Indians.

the Beavers are slight in build, much less broad-faced and coarse-featured and with pleasant expression. They are evidently lithe and active but comparatively weak, and show a considerable resemblance to the woodland Crees in appearance.

The D'Echafaud at camp was found to be 728 feet above Dunvegan or 2030 feet above the sea level.

Plateau east of the D'Echafaud.

August 13*th*.—On leaving camp travelled northward along the river bank to find a trail which we had learned from the Indians would lead us to Dunvegan. Having found the trail, we crossed the river and turned eastward over the plateau, with a general elevation of 2380 feet, for a distance of fourteen miles. Small open meadows and prairies, aspen groves and thickets, willow coppice and tall well-grown woods of spruce and aspen alternate. Met with occasional swampy spots and some fallen timber, impeding progress, but almost the whole region is susceptible of cultivation. The trail we had attempted to follow is a very indistinct one and evidently not much used. We were frequently quite at a loss to trace it, and eventually missed it altogether in an extensive burnt patch. Camped at 5 p.m. at a little brown sluggish stream surrounded by wide swampy meadows and blocked with many old beaver-dams. Altitude of camp 2310 feet above sea level. Latitude by meridian altitude of θ Aquilæ 55° 53′ 34″.

Obtain a guide.

August 14*th*.—Having now made by account sufficient easting to reach the longitude of Edmonton, had determined to turn northward in search of that place, but two Indian lads who came into camp and spent the night with us, insisted, as far as we could understand them, that the place was still further east. Having induced one of them to act as guide, set out again in an easterly direction. The guide proved to be very useful, as there were many indistinct Indian trails and hunting tracks running in all directions. Camped at 5 p.m. beside a small stream in a thick wood, but with good grass on the slopes for the animals. Height of camp above sea level 2280 feet. Latitude by meridian altitude of Altair 55° 49′ 54″.

Character of the Plateau.

The country passed over resembles that previously described, the surface being nearly uniform, and the highest point attained between the sources of several small streams having a height of 2670 feet. The region is generally thickly wooded when not burnt over, the trees being chiefly aspen and scrub pine where dry, spruce where damp. From half to three-fourths of the region is well adapted for cultivation, with a rich soil.

Meet Mr. MacLeod.

August 15*th*.—Travelled eastward thirteen miles through country similar to that just described, but chiefly wooded with poplar. About 1 p.m. unexpectedly met Mr. MacLeod with a few men and horses on

his way westward. Camped, and discussed arrangements for remaining explorations.

August 16th.—Having now reached a well-beaten trail, made a journey of twenty-one miles and camped on the south bank of Peace River opposite the Hudson Bay post of Dunvegan. Four miles from morning camp crossed the Rat River, a small stream thirty feet by two to three feet when in flood, but flowing northward in a valley 240 feet deep, with scarped banks. The plateau at the bank of the valley has a height of 2250 feet above the sea. Passed through open poplar woods for a few miles after leaving camp till the whole country became open and prairie-like, with poplar and willow coppice in the hollows; the surface gently rolling or undulating and covered with luxuriant grass and wild pea, and gay with Asters, Erigerons and Solidagos. From little hills an extensive view of similar prairie country opens to the south-eastward, while to the southward it is bounded at a distance of about twelve miles by the edge of a low wooded ridge or plateau. No mountains or high hills can be seen on any bearing. About ten miles from the edge of the Peace valley the trail enters a belt of poplar woodland with small open meadows. The woods gradually become thicker as we approach the river, being protected from the sweep of fires by the numerous steep-sided ravines and gullies which ramify from the main depression. Emerging at length upon a beautiful rounded grassy promontory, the great Unjigah or Peace River is discovered flowing in a broad tranquil stream in a valley two to three miles wide and eight hundred feet deep.

Rat River.

Fine Prairie.

The river and its valley, as far down as the mouth of Smoky River, have already been fully described by Mr. Selwyn in the Report of Progress for 1875–76, and need not here be further specially referred to.

Description of Peace Valley.

Both Beaver and Cree Indians are now found on this part of the Peace River, though the country really belongs to the former. The extent of the Beaver territory is as follows:—Northward to the Battle River, eastward to the Smoky and Simonette Rivers, southward to Grand Coup Plat, a tributary of the Smoky, westward to the Portage of the Mountain of Rocks on the Peace River, where they mingle with the Siccanies. On Pine River and other south-western streams, the Beaver country extends to the mountains. The Beavers are now a small and weak people. The Crees are encroaching on them from the east side of Smoky River, while a band of Iroquois hunters and half-breeds has taken possession of a considerable part of the southern country, between Dunvegan and Jasper House.

Country of the Beaver Indians.

The Siccanie Indians call the Peace River the Tsĕ-tai-e-ka, a name meaning "the river which runs by the rocks," in allusion to its passage

Names of rivers.

of the Rocky Mountains. The Cree name is A-mis-kwe-i-moo-sī-pī, or the Beaver Indian River. The Cree name for the Smoky River is Ka-ska-pa-tē-sī-pī with the same signification as the English name. That of the Little Smoky is Ka-ska-pa-tē-sī-pī-sīs.

GRANDE PRAIRIE, AND DESCENT OF SMOKY RIVER.

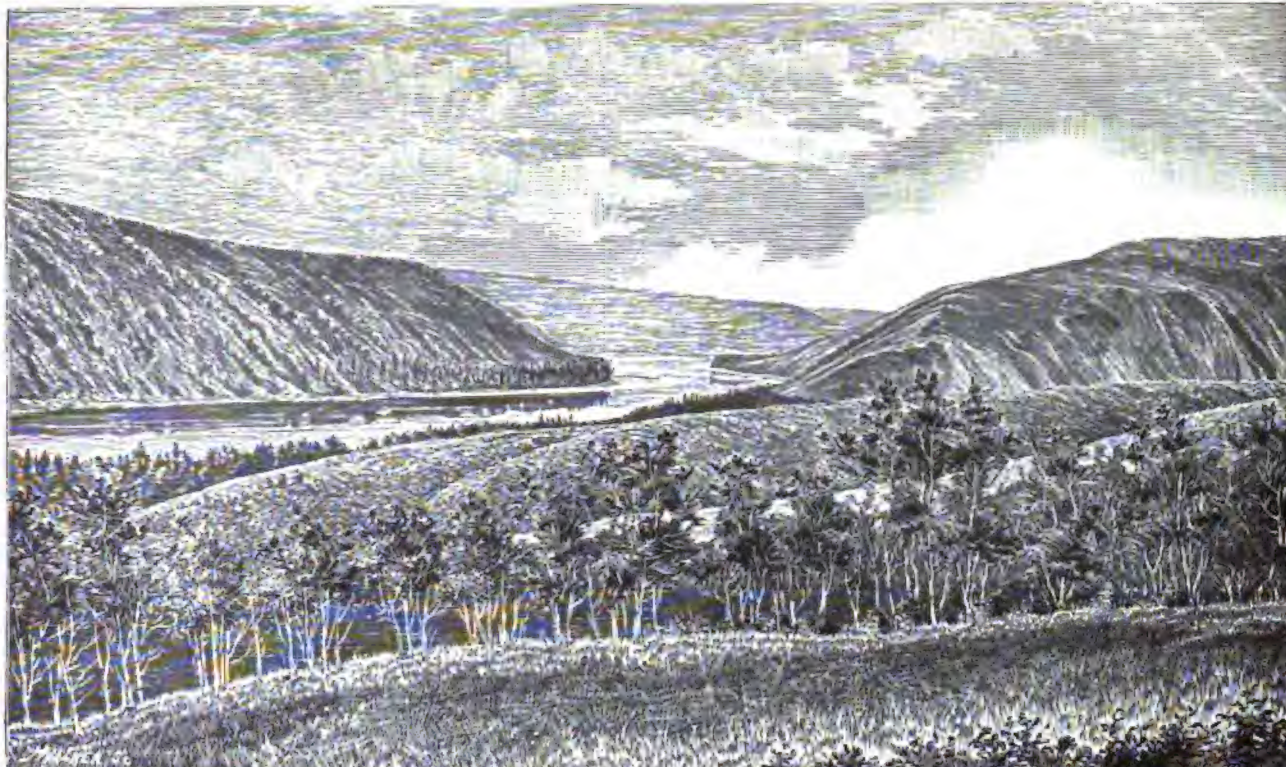
Plans adopted. Having ascertained from Mr. MacLeod that it was likely that his expedition to the westward would occupy him till about the end of the month, and that Mr. Cambie, who had set out for Lesser Slave Lake, would not be back till the same time, on arriving at Dunvegan on Saturday, August 16, I immediately organized two small parties. With one of these I set out to the southward on Monday morning, having with me a packer, three British Columbian Indians, and a half-breed as guide, with riding horses for the party and three pack animals. My assistant, Mr. McConnell, accompanied by the Rev. Mr. Gordon, left Dunvegan at the same time with instructions to penetrate as far to the northward as possible. He had with him a packer, a Beaver Indian as guide, and a half-breed to act as interpreter to the guide, three pack animals and five riding horses.

Trails. Several trails run southward from Dunvegan toward Grande Prairie and the head waters of the Smoky River, and the Indians travel through in this direction to Jasper House on the upper Athabasca. Many little hunting trails and dim tracks ramify from the main trails in all directions, in conducting us among which our guide was of great service as long as we confined ourselves to the part of the country with which he was familiar.

Prairie country. After passing through the belt of woodland already mentioned as bordering the Peace River valley, the trail to Smoky River emerges on the beautiful rolling prairie country previously described, and passes over it in a south-south-eastward direction for about ten miles. At eight and a half miles from Dunvegan the Ghost or Dead River is crossed, at sixteen miles the Rivière Brulé. These streams both flow eastward, and meeting, eventually reach the Peace about fifteen miles below Dunvegan under the last mentioned name. The Ghost River, where crossed by the trail, is a small stream in an inconsiderable valley depressed about forty feet below the prairie, the Rivière Brulé in August was about twenty feet wide by six inches deep, or in flood forty feet by two feet. Its valley is 1000 feet wide and about a hundred feet deep.

Higher plateau. A short distance beyond the Rivière Brulé, the trail begins gradually to ascend a broad ridge, gaining eventually an elevation of about 200 feet above that of the prairie, and passing at the same time into a wooded country. This higher tract has been referred to as a ridge, but has at

Plate 4.



G. M. D., Photo. Aug. 31, 1879.

LOOKING UP PEACE RIVER VALLEY FROM HILL BEHIND DUNVEGAN.

this place a width of about seventeen miles. It runs north-eastward and south-westward, but in the latter direction soon turns to a nearly east and west course, continuing to bound the Grande Prairie to the north for many miles. Where crossed on this trail, the north-eastern part of this higher plateau is about three-fourths woodland, with many pretty little prairie openings. For about six and a half miles before reaching the northern margin of the Grande Prairie, the woods become dense, consisting of aspen, alder, cottonwood and birch, with an occasional spruce.

The soil of the prairie to the north of the higher plateau is uniformly fertile black loam, of the higher plateau in some places a little coarser, and with here and there a few boulders appearing, but all rich. At twenty-two miles from Dunvegan Ka-toot Lake, about a mile in length, is reached. It drains south-eastward toward Bad Heart or Ma-atz-i-ti he-sī-pī of the Crees, which six miles further on is crossed. This has a valley two hundred feet deep and about half a mile wide, the stream being fifteen feet by four inches, or in floods about forty feet by two feet. It flows eastward to the Smoky River.

Soil.

Bad Heart River.

The so-called Grande Prairie is a tract of country about forty miles in extreme length in a north-east and south-west direction, and where widest over twenty miles in width. It has an area of about 230,000 acres, and is included between the southern slopes of the ridge or higher plateau above mentioned, the Smoky, the Wapiti and Beaver Lodge Rivers. It is drained by the Kles-kun stream flowing eastward to the Smoky River, by the Bear River which crosses it from north-west to south-east, and at its western extremity by the Beaver Lodge. Kles-kun and Bear Lakes, about three and six miles in length respectively, besides many smaller sheets of water, occur on the prairie.

Grande Prairie

The surface of Grande Prairie is not monotonously undulating like that described to the north, but may rather be characterized as forming a series of gently sloping ridges or swells between the various river and stream courses, which are here not found to cut deep gorge-like valleys. The features of the region seem to have been produced by the long-continued and uniform progress of denudation. Much of the country is park-like with groves of poplar, while extensive tracts are quite open, or with coppice along the stream valleys only. Toward the edges the prairie very often blends almost imperceptibly with the woodland by the gradual increase and coalescence of the patches of poplar and willow. The *Amalanchier* or service berry is exceedingly abundant, and here bears larger and finer fruit than I have seen elsewhere. On the 20th of August the berries were over ripe except in shaded places, and the Indian berry harvest was over. Both Cree and Beaver Indians often come long distances for the berry gathering at Grande

Aspect of the country.

Berry Harvest.

Prairie, and after having secured and dried a sufficient quantity of fruit, scatter again in small bands into the more remote parts of the country for the autumn hunt.

Fertile soil.

The soil of Grande Prairie is almost everywhere exceedingly fertile, and is often for miles together of deep rich loam which it would be impossible to surpass in excellence. The low ridges sometimes show rather light soil with an admixture of sand or gravel and a few boulders, but a very small proportion of the surface is unfavourable for cultivation. Buffalo trails still score the sod in all directions, and are deeply hollowed out where a number converge toward the crossing of a river or lake, or some such place. The saucer-shaped 'wallows' of the buffalo and scattered bones are also numerous, though the animal is now no more seen here. The Indians state that the extinction of the buffalo was not entirely due to the introduction of fire-arms and the the active hunting carried on for the supply of the Hudson Bay forts, but that all remaining were killed many years ago by an excessively severe winter when the snow was over the buffaloes' backs. It may be mentioned in this place that the Beaver Indians report having seen in the summer of 1879 six woodland buffaloes, of which they killed one, in the vicinity of the Pouce Coupée prairie. Kles-kun Lake is evidently shallow, and surrounded about its lower or eastern end by extensive marshes, producing fine natural hay. The slopes along its northern side are particularly noted as affording good winter pasturage for horses. The marshes are in some places more or less saline, and *Salicornea* was abundant in a few spots. Ducks, geese, cranes and other similar birds are exceedingly numerous about Kles-kun Lake in the autumn. A low gently swelling ridge separates the valley holding Kles-kun from that holding Bear Lake or Sus-mi-gi of the Beaver Indians. This lake is fringed with grassy swamps and coppice, and is probably deeper than Kles-kun Lake.

Extinction of buffalo.

Woodland buffalo.

Lakes.

Bear River.

The valley of the Bear River, Sus-za-ka of the Beavers, for some miles west of the lake, is, for country in a state of nature, singularly beautiful. Two and a half miles from the lake, the river flows in a trough-like depression 500 feet wide and thirty to forty feet below the general level of the wide valley. The stream at the time of our visit was thirty feet across by two deep, rapid and rather difficult to ford on account of its steep soft banks. The water is brown and evidently drawn from swamps. Klo-es-sa-ka or Fish Creek, a rapid stream ten feet wide by six inches deep, coming from the westward, joins Bear River a short distance above the lake. South of these streams is the Isle de Montagne or Sis-tin of the Beavers, a wooded flat-topped hill rising about five hundred feet above the river valleys, and probably an outlier of an old higher plateau. The Beaver Lodge River or Uz-i-pa

Isle de Montagne.

passes to the south-west of the Isle de Montagne, flowing south-eastward to the Wapiti. It occupies the bottom of a valley two to three miles wide, with gently sloping banks. It was about thirty feet wide by six inches deep where rapid, and flows in a trough cut eighty feet deep in the bottom of the wide valley. The north-eastern slopes of valley are open prairie, but to the south and west the eye ranges over a great extent of wooded country. This is in fact the edge of the Grande Prairie in this direction. Beaver Lodge River.

The Wapiti River, Elk River or Riviere la Biche, which may be considered as bounding the Grande Prairie country to the south, joins the Smoky River in latitude 55° 9′ 30″ longitude 118° 34′. In August it was found to be about three hundred feet wide and so rapid and deep as to require caution in fording. Its water differs from that of the smaller streams above described in being charged with fine mud, and is doubtless partly derived from melting snow. Our guide pointed out to us a high snow-covered peak in the Rocky Mountains, situated about fifty miles south-westward from the mouth of the Wapiti, as being near the source of the river. The valley of the Wapiti averages probably a mile in width and is depressed about 400 feet below the plateau bordering it. Along the west bank of that portion of it examined, the country for some miles back is sandy and poor, with ridges and mossy swamps. The northern slopes of the valley itself in its lower part are irregular, with sandy and gravelly ridges covered with scattered trees and scanty herbage. Wapiti River.

A traverse was made south of the Wapiti River, between that stream and the Smoky, for the purpose of ascertaining the character of the country. Seen from high points on the Grande Prairie this district forms part of a wide nearly level or gently undulating wooded region, which stretches to the distant foot hills of the Rocky Mountains. On the traverse above mentioned the country was found to be generally lightly wooded with poplar and coniferous trees, though dense belts of spruce, in which the trees are sometimes of a large size, also occur. The surface is slightly undulating, and the soil,—especially near Wapiti River—in places light. At least half the surface, however, would, if cleared, be well adapted for agriculture. Country south of the Wapiti.

On reaching the bank of the Smoky River—which we did on the trail followed in latitude 54° 53′ 4″—we hoped to find a small canoe which we were assured had been left there by a hunting party in the spring, and in which I wished to descend the Smoky River to the Peace to examine any rock sections which might occur. Being unsuccessful in our search, and wishing not to lose the time necessary to make a canoe for ourselves, we waited till noon to ascertain the latitude, as above given, and then travelled back fifteen miles to the Turn back from Smoky River.

crossing of the Wapiti, where we had already found a small cottonwood canoe 'cached'. The Smoky River valley at the point just mentioned is two and a half miles wide and over 300 feet deep. The banks are not precipitous and the bottom is wide, with beaver dams and swampy meadows and fine large cottonwoods in dense groves.

Arrangements for return.

Directing the packer with our guide and one Indian to return at once to Dunvegan, and after obtaining fresh animals there to go on to the mouth of the Smoky to meet us, I got the little canoe above mentioned launched, and with two British Columbian Indians set out to descend the Wapiti and Smoky Rivers to the Peace. We knew that the Indians hunting in this part of the country not unfrequently ran down the Smoky River in canoes, but were not prepared to find it so rapid as it proved. We arrived at the Peace River safely on the evening of August 28th, after a voyage, following the course of the river, of one hundred and twenty miles, and the packer and animals arriving next morning, we rode back to Dunvegan, arriving at 3 p.m., on August 30th.

Wapiti River.

From Mountain Creek, where we embarked on the Wapiti River, to the mouth of the latter—thirteen miles in a straight line—the banks of the valley continue generally wooded with moderate slopes, and show no extensive slides, though frequent small exposures of rock occur at the water's edge. Flats at about ten feet above the river are somewhat extensive but appear to be liable to be flooded. Seven and a half miles from the mouth of the Wapiti the Bear River joins it from the north-west. About a mile and a half below the mouth of the Wapiti, the Smoky is joined from the east by the Simonette River, a stream forty to fifty feet wide by two feet deep with moderately rapid current. This occupies a deep but narrow valley, and is said to head not far from the upper part of the Smoky at a considerable distance to the southward. It is doubtless the upper part of this stream which was crossed by Mr. E. W. Jarvis in his adventurous winter journey across the Rocky Mountains in 1874*. An easy crossing of the Smoky River for a railway line can be obtained by following the valley of the Bear River and the north bank of the Wapiti, crossing the Smoky River at the confluence and making grade to the plateau level again in the valley of the Simonette.

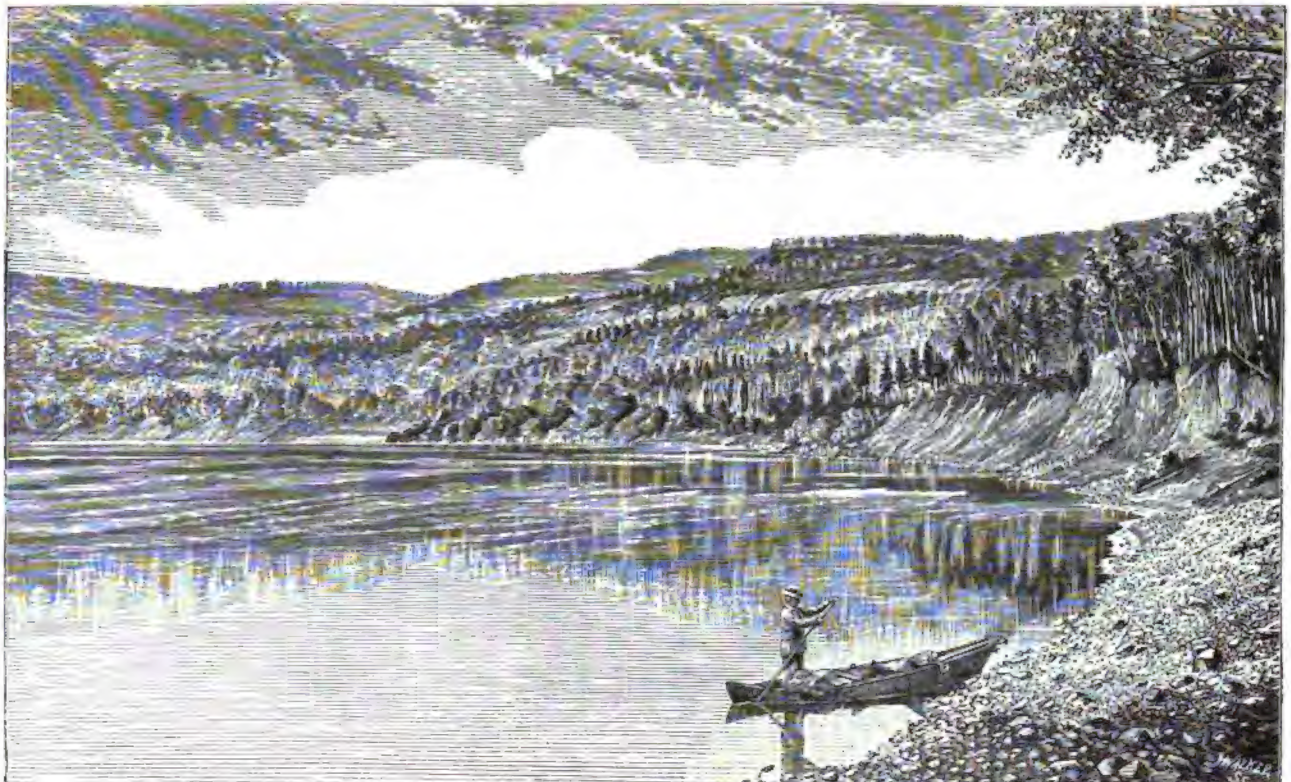
Simonette River.

Railway crossing.

Smoky River.

From the mouth of the Simonette to the confluence of the Little Smoky River—forty-two and a half miles in a straight line, or about sixty miles by the course of the river—the valley is from a mile to a mile and a half wide from rim to rim. The banks in many places show the effects of very extensive slides, which have brought the soft

* Canadian Pacific Railway Report 1877, p. 155.



G. M. D., Photo. Aug. 26, 1879.

VIEW ON SMOKY RIVER NEAR TRAIL CROSSING.

Cretaceous beds down from the level of the country above to the water's edge in broken and confused masses. These are generally old, but some are evidently still occasionally in motion, and covered with trees thrown at all angles by the disturbance. Scarped banks of these soft rocks from one to two hundred feet high also occur in some places. All southern exposures are in general grassed, while the shady parts of the valley are wooded. The flats bordering the river on alternate sides are from ten to twenty feet above it, being higher near the Little Smoky. The Little Smoky is much less in size than the Wapiti River.

The point at the junction of the Smoky and Little Smoky is an irregular mass of sombre Cretaceous shales, and here is situated the only one of the '*bocannes*' which have given the river its name, at present in action. Several other places where a smouldering combustion has at some time occurred, are marked by spots of red baked clay in the banks, but at this place a thin column of smoke is still issuing. This phenomenon is again referred to in treating of the Cretaceous rocks on a following page.

Bocannes.

After making a few abrupt turns below the mouth of the Little Smoky, the main river flows in a nearly straight line to its confluence with the Peace. The valley continues with much the same character as before, slides and scarped banks alternating with grassy or wooded slopes. The river becomes very wide and shallow in some places, especially for several miles before reaching the Peace, and there are several strong rapids. The Cretaceous sandstones which now prevail in the banks are nodularly hardened, and large blocks of these indurated portions of the rock derived from old slides obstruct the river bed in some places, rendering the rapids more difficult to run. It is possible that a stern-wheel steamer of considerable power could ascend the Smoky River for some distance, perhaps even as far as the mouth of the Wapiti, but this would be at best for a short time each year, and the river can in no proper sense be accounted a navigable one.

Lower Smoky River.

It was on the Peace River about six miles above the mouth of the Smoky that Sir Aléxander Mackenzie built a post in the autumn of 1792, and wintered preparatory to his exploration of the then unknown country to the westward.

Old Post.

The trail from Smoky River to Dunvegan lies at a considerable distance from the river, and passes almost all the way through a country which may be described as prairie. The plateau is nearly level beyond the heads of the numerous ravines which run toward the Peace, wide grassy stretches alternating with aspen coppice and patches of willow. Considerable patches of burnt aspen of larger growth also occur, and it is evident that fire passes at intervals over all this part of the

Country between Smoky River and Dunvegan.

country keeping down the young growth of trees. Near Dunvegan, for some miles, the surface becomes undulating and broken from the action of denundation sweeping toward the main river valley. This undulating region is pretty densely wooded with aspen. The soil is everywhere exceedingly fertile and the general aspect of the country very beautiful.

Description by Mr. McConnell of the Country North of Dunvegan.

The following notes, which may be introduced here, are by my assistant, Mr. McConnell, and accurately describe the country examined by him northward from Dunvegan to the Battle River, a stream which flowing eastward joins the Peace about a hundred miles below the Smoky River:—

Plateau north of Dunvegan.

North of Dunvegan the plateau level is attained at about a mile from the fort, and is about 800 feet above the river. The highest point reached by the barometer during the day being 27·48, while at the river level it read 28·452. For several miles after reaching the plateau, the country passed through was somewhat rolling, and dotted with aspen coppice, but gradually the rolls ceased, and at a distance of about six miles from the river the surface became almost perfectly level. As far as the eye could reach nothing met the view save a level plain with here and there a clump of aspens, the whole being admirably adapted to agriculture. The soil displayed where the trail had been worn somewhat deeply was a heavy clay, covered with rich black mould often over a foot in depth. Neither swamps or muskegs and but two gullies were passed over or seen in any direction. This style of country continued for a distance of about fifteen miles from the river, and then commenced gradually to change for the worse. As we approached Hay Lake the country became more swampy and wooded, while with the aspens were now mixed a considerable number of spruce.

Fine prairie country.

Hay Lake.

Hay Lake is about a mile and a half in length by three-quarters of a mile in width, and is so called from the marshes around it affording a large quantity of wild hay. After leaving Hay Lake the trail we followed bends more to the west and leads on to Lac des Isles, distant from Hay Lake about four miles. This lake is somewhat larger than the last and contains numerous islands. Between the two lakes, the country for the greater part of the distance is chiefly wooded with aspen and spruce, and though the trail passes over firm ground nearly all the way, still on either side of it were seen large tamarac swamps and open marshes. But the country seen here cannot be taken as a safe criterion of its character at any distance from the trail, as the swamps

Lac des Isles.

and marshes are probably due to the proximity of the lakes, the land between them being very low. About half way between Hay Lake and Lac des Isles, a small stream about twenty-five feet wide by a foot deep, and into which both lakes discharge, was crossed; this is the same stream which falls into Peace River about half a mile above Dunvegan, and up the valley of which the trail now led for a considerable distance.

Country north of Lac des Isles.

On leaving the Lac des Isles the country improved considerably, but yet remained far inferior to that in the vicinity of the river. The valley of the stream which we now followed up is about seventy-five feet deep, and varies greatly in width, now narrowing down to about a quarter of a mile, then spreading out to several miles—and giving off at intervals, on either side, large lateral valleys. Here the country is again rolling, with woodland and open prairie alternating with occasional swamps. The soil, though on the whole good, is sometimes light, the tops of the highest rolls showing sand or gravel. About twelve miles north of Lac des Isles we left Muddy Creek, which here turned abruptly westward, and headed, as we were informed by our Indian guide, at a lake several miles long lying at the foot of the same range of low hills which now stretched across our path from east to west. This range we found on crossing it to be about nine miles in width, the hills varying from 400 to 500 feet in height. It appeared to run in a south-westerly direction, but owing to its densely wooded condition, from no point could we obtain more than a glimpse of the country around. The trees were principally small aspens, but a couple of muskegs were passed over on which spruce was growing. On the southern side of this range and the greater part of the way across it, the land is of little value, but the northern slope, being very gentle, displays quite a large area of good land. Descending this slope, we found at its foot the largest muskeg observed in the whole trip. In this swamp headed a small stream which flowed northwards to White Mud River, the range of hills constituting the watershed between that river and the streams flowing southward to Peace River.

Range of hills.

Muskeg.

After passing with difficulty through this swamp, which is about three miles in width, we found that the country gradually improved. First swamp and aspen bush alternated with one another, then all became aspen bush, and at last an open prairie. About six miles from the foot of the hills we came to a large stream called White Mud River, about fifty feet in width by about a foot and a half in depth. It flows in an easterly direction, and the country we descended into appeared to be its valley. If so, it is from north to south, where the trail crosses it, about fifteen miles in width, but appears to narrow westward, another

White Mud River.

range of hills running from the south-east seeming almost to close it up. Between these two ranges of hills, and stretching eastward and south-eastward as far as the eye could reach, is a large area of magnificent country, slightly rolling, and dotted here and there with clumps of aspen and willow. This reach of country, according to half-breed report, follows White Mud River to its mouth, and bears the same character throughout. This would make it about fifty miles in length, with probably an average width of twenty miles. It appears to be about the same height as the plateau above Dunvegan, or 2200 feet.

Fertile prairie.

Country north to Battle River.

The banks of White Mud River are about fifteen feet in height, but showed no rock sections whatever, the cutting being chiefly through a stiff grey clay. The bed of the stream was filled principally with Laurentian gneissic boulders, together with a small number of well-worn sandstone rocks. After leaving White Mud prairie, the country again grew worse, the proportion of swampy land being on the increase, and the prairie land also giving way to aspen bush; but getting past the watershed between White Mud River and Battle River it again improved, and from this point on to Battle River, a distance of about twenty-five miles, it maintained the same general character, showing scarcely any prairie, but being covered with a thick growth of aspen and willow, and with a very small proportion of swampy land. Battle River, flowing in a valley about a mile in width and 200 feet in depth, is in low water about seventy-five feet wide and about a foot deep, but during floods it must be a large stream of a couple of hundred feet wide and three or four feet deep. A walk of several miles up and down the stream discovered no stratified rocks *in situ*, though several bluffs were seen from fifty to seventy-five feet high, but consisting principally of sand. Most of the rocks in the stream appear to have come from a distance, gneissic and granitic boulders forming by far the greater proportion of them. Along with these are some of greyish crystalline fossiliferous limestone, and rounded and angular blocks of sandstone, some of them containing fossils, also a small proportion of blackish shale, porphyry, &c. The river is very winding, and runs in an easterly direction. According to the account of a Cree hunter whom we met there, it receives two other branches from the north, each as large as itself, before falling into Peace River, which by his account was two days' journey from this point, or probably about forty miles.

Battle River.

Amount of good land.

As a rough estimate of the amount of good land lying between Peace River and Battle River, a distance of eighty-five miles, I should say that fully three-quarters of it is fit for cultivation, the rest being too wet, and the greater part of the cultivable area, including White Mud prairie, being really first-class land, equal to any which I have seen in any other place in the North-west.

At Battle River the fall appears to set in very early. Although it was but the 24th August when we were there, yet the leaves of the aspens were already yellow, and were falling off. This appears to have been due to the cold of the night of the 20th August, when the thermometer registered 12 degree of frost, as before that they were quite green, and on our way back after recrossing the hills we found them again comparatively green. This frost, according to the experience of the Hudson Bay Company's people, was quite exceptional in its severity at so early a season, but besides it two other light frosts were experienced on the trip. **Climate.**

Extracts from Mr. Cambie's Report.

To complete the information obtained during the exploration of the summer of 1879 for the Peace River country west of Dunvegan, the following notes from Mr. H. J. Cambie's report on the region between Dunvegan and Fort St. John and Hudson's Hope, on the north side of the river, and thence southward to Pine River, may be quoted.* As already stated, the river itself has been fully described in the Geological Survey Report of 1875-76 by Mr. Selwyn :—

"From Dunvegan we travelled northward for a day and a half, say thirty miles, and then westward at an average distance of fifteen miles from the Peace River to Fort St. John. * * For the whole distance, nearly 120 miles, the plateau undulates considerably, ranging from 1900 to 2400 feet above the sea level. And for forty miles, after turning to the west, there was a range of hills a few miles to our right rising from 600 to 1500 feet above the adjacent country. My guide informed me that the streams on the other side of that ridge drained into the Battle and Liard Rivers. **Country west of Dunvegan.**

"Eleven streams, from twelve to forty feet in width were crossed, besides numerous smaller ones, and Pine River North, which is situated about six miles from Fort St. John, and was then 100 feet wide by two feet deep, but at high water must be 300 feet wide, in a valley 700 feet deep and a quarter of a mile wide in the bottom. The slopes on both sides are much broken by old land slides. **Streams crossed.**

"On the west there is a bluff of decomposed shale, and on the face of the eastern slope many ledges of sandstone in nearly horizontal beds.

"We saw a few small open muskegs, and had to cross one about one mile in width which delayed us more than four hours.

"The soil is composed of white silt with a good covering of vegetable mould, but for one stretch of fourteen miles, this has been completely burnt off. We also passed over two gravelly ridges.

* Canadian Pacific Railway Report, 1880, p. 50.

Prairie and woodland.

"A few large prairies were seen, and many small ones interspersed with poplar and willow copse.

"Twenty-five per cent. of the distance, lay through woods of small poplar, spruce and black pine; near Pine River North, there was also a belt three miles wide of spruce six to fifteen inches in diameter."

Trail from St. John to Hudson's Hope.

The trail from Fort St. John to Hudson's Hope, most of the way, followed the valley of the river, and was on the plateau only for twelve miles after leaving Fort St. John, for about three miles near Middle River, half-way between the two places, and again for a short distance about six miles east of Hudson's Hope.

Soil.

"The soil is rich at each of these places, with prairie and poplar and willow copse, also a few small groves of poplar and spruce four to twelve inches in diameter. On the benches next the river, the soil is in some places light, and between Middle River and Hudson's Hope, there is one stretch, six miles in length, gravelly and almost barren. That description of land also extends the whole way across the Rocky Mountain Portage. * * *

Hills.

"Regarding the country north of Peace River, I noticed that from the eastern base of the Rocky Mountains, about twenty miles north of Hudson's Hope, a range of hills extends, nearly due east till it meets the Peace River, about twelve miles below its junction with the Smoky River.

"The tract of country lying south of that range, and between it and the Peace, is generally fertile, but that portion of it west of the longitude of Dunvegan is more undulating and at a slightly higher elevation than the other portions of the plateau in the Peace River district, which I had travelled over, and has an appreciable percentage of poor soil."

Plateau south of Hudson's Hope.

The plateau south of Hudson's Hope is said to be 2000 feet in elevation, but a ridge rising 900 feet higher is crossed at five miles, and a descent made to Moberly's Lake, which has an elevation of 2050 feet. The country between Moberly's Lake and the Pine River is described as a mountainous and hilly district, sixteen miles in breadth, rendered almost impassable by fallen timber, the only prairies being on the slopes of steep hills facing the south.

Moberly's Lake and southward.

"In the first five miles from Hudson's Hope we had crossed two small tamarac swamps and some stretches of light, sandy soil, with a small growth of poplar and spruce. We had again met with some level land in the valley of Moberly's River, which for nine miles above the lake averages nearly half a mile in width in the bottom. Some portions of this are gravelly and barren, and others fertile, with a few small prairies producing rich grass. There are also some fine prairies at the lake, on slopes facing the south. Between Moberly's Lake and

Pine River there is now a young growth of spruce, black pine and poplar, but the piles of fallen timber proved the existence not long ago of spruce forests of moderate size, and a few belts of that timber, six inches to twenty-four inches in diameter, having escaped the ravages of the fire, are still standing."

Description of Country between Dunvegan and the Athabasca River.

August 21st and the four following days were spent at Dunvegan, in the preparation of a preliminary map and report on the character of the country, and in arranging about supplies and dividing the pack train, the larger part of the animals returning with Mr. Cambie to British Columbia. The season being now far advanced, and no word received from the party which was to have opened a trail from Dirt Lake, west of Edmonton, to Dunvegan; Mr. MacLeod and I decided to divide between us the work necessary to complete exploratory lines to Dirt Lake and Lac La Biche, as in the event of either the Pine or Peace River pass being chosen as a railway route, it appeared absolutely essential that surveys should be connected in both these directions. We left Dunvegan finally on the 5th of September, Mr. MacLeod and I setting out for the upper part of the Athabasca River, while Mr. McConnell had instructions to go to Lesser Slave Lake, and make his way by the best route he could find to Athabasca Landing, where he was to meet me early in October.

Re-arrange parties and leave Dunvegan.

We were able to procure a guide who engaged to take us as far as Sturgeon Lake, toward our objective point on the Athabasca, and travelling in the first instance to the mouth of the Wapiti River, we there crossed the Smoky, intending to strike eastward to the lake. Our guide, however, informed us that the intervening country was a mass of burnt woods and windfall through which he had had great difficulty in travelling on snow-shoes in winter, and quite impracticable for animals. We were therefore obliged to make a long detour to the north, and arrived at Sturgeon Lake on September 14th. There are here a few rough log-houses inhabited by Cree Indians, who cultivate small garden patches. We found, however, that nearly all the men were away on the autumn hunt, and were told that it would be quite impossible to travel south-eastward to the Athabasca owing to the great areas of heavy windfall and swamp. We managed at length, however, to procure a lad as guide, who agreed to lead us to where one of the parties was, and there we hoped to find a man better acquainted with the country. Without entering further into particulars as to the journey, it may suffice to say that after penetrating a very difficult

General description of route followed.

country we reached the bank of the Athabasca in latitude 54° 7′ 34″, approximate longitude 116° 48′, on the 24th September.

Country between Smoky River and Sturgeon Lake.

Between the Smoky River and Sturgeon Lake, lies a ridge, or area of higher plateau, which exceeds the general level by two or three hundred feet. The route followed from the mouth of the Simonette lay round the north end of this ridge, as we were forced northward by wet country till we fell into the trail which leads from the lower or Cambie's crossing of the Smoky River to Sturgeon Lake. The country may be described as in general densely wooded, the forest being for the most part second-growth, and composed of aspen, birch, *Pinus contorta*, spruce and cottonwood, generally of medium or small growth. Considerable tracts are covered, however, with heavy original spruce or aspen forest. There are many little prairie openings, especially along the banks of streams, and considerable tracts of burnt country still more or less encumbered with the half-consumed logs, but affording excellent pasture for animals. Swamps, generally produced by beaver-dams are often met with, and the evidences of old beaver work are very frequent, though comparatively few skins are now obtained in this part of the country. The stream beds are not generally depressed more than ten to forty feet below the level of the plateau. The valley of the Pus-kwas-ka-mon, a considerable brook, is followed eastward till within five miles of Sturgeon Lake, when the watershed is crossed at an elevation of 250 feet above Sturgeon Lake. The soil is generally good and in some places very fertile. It is composed of the white silt previously referred to, with a surface coating of vegetable mould of variable thickness. A few Laurentian boulders and quartzite pebbles were observed on the slopes of the ridge or higher plateau.

Sturgeon Lake.

Sturgeon Lake, or Ke-me-sis Sa-ga-he-gun of the Crees, is probably about eight miles long and lies nearly east and west. It is constricted in the middle and its western end was not seen. Its elevation is about 2000 feet. It is probably shallow and its banks are uniformly low, sloping up gradually to a height of about one hundred feet before attaining the plateau level. There is good pasturage and a fine partly open country on the north-eastern border of the lake, along which we passed to reach the Cree settlement. The Indians here own some horses, which they winter on the grassy banks of a second large lake lying to the south of Sturgeon Lake.

Country south of Sturgeon Lake.

Twenty-one miles south-eastward from Sturgeon Lake, the bank of the Little Smoky River was reached. The intervening country is for the most part wooded, but with little prairies along the borders of the streams. The surface is gently rolling the differences in elevation not exceeding a few hundred feet. A few mossy and peaty swamps were traversed, but the area of these is comparatively inconsiderable. The

soil is generally good, though in some places becoming rather hard and clayey and then bearing dense groves of spruce.

From the point when the Little Smoky River is first reached, its course is in the main followed for thirty-six miles by an indistinct trail which crosses and re-crosses the stream in a number of places. The river averages from 250 to 300 feet wide with generally a stony bottom. In September it was two to three feet deep, with a moderately swift current. The valley is not deep and trough-shaped like those of many other rivers in this region, but wide and shallow. Where first touched on it is depressed about eighty feet only below the plateau, and is from three-quarters of a mile to a mile in width. Further up the valley is from a quarter of a mile to half a mile in width, and scarcely more than fifty feet below the plateau. In approaching the Athabasca, the country is evidently not only increasing slowly in altitude, but decreasing in value. The soil of the plateau becomes sandy in many places and swamps are more extensive. The valley of the Little Smoky, however, continues very beautiful, prairies with fine natural grass and pea-vine, alternating with open woodland. The Indians say that the Simonette, the Little Smoky and the Baptiste Rivers,—the two former flowing into the Main Smoky the latter into the Athabasca—rise near together in the Rocky Mountains. Where the valley of the Little Smoky turns abruptly to the westward the trail leaves it, turning to Ī-a-pe-oo or Buck Moose Lake, a few miles off.

Valley of Little Smoky.

Sources of rivers.

In the portion of its course above described, the Little Smoky is joined by four considerable tributaries. On the right bank, the Ī-o-sē-gun and Ī-a-pe-oo Rivers, the former with a flood channel half as wide as that of the Little Smoky and coming from a lake to the south-eastward; the latter, probably also a stream of some size, from the lake of the same name above mentioned. On the left bank the Big Beaver Lodge and the Walk-an-ă-gan or Tamarac Rivers.

Tributaries.

Ī-a-pe-oo Lake is about three-quarters of a mile wide and at least two miles long, neither end having been distinctly seen. It is surrounded by barren sandy ridges lightly clad with spruce, with intervening deep mossy swamps. From this point to the bank of the Athabasca—twenty miles—there is no visible trail, and the country is exceedingly difficult to traverse, having been for the most part burnt over only a few years ago, the dead trees now forming either almost impassable windfall or standing in thick masses of bleached and bare trunks. In a few places the second growth has attained some size, and in occasional spots patches of the heavy original forest covering, composed chiefly of large spruce trees, have been preserved. The surface is diversified by ridges which rise in some places nearly 200 feet above the intervening hollows, and still continues gradually rising toward the

Country bordering the Athabaska.

Athabasca. At eight miles from the Athabasca the watershed between this river and the Peace is crossed, with an elevation of 3300 feet. Four miles from the Athabasca we crossed the Marsh Head River, a tributary from the eastward. The stream is about forty feet wide by two to three feet deep, and flows in a deep valley over three miles in width. The soil is generally light, the silt often turning to actual sand, but considerable areas of land of fair quality are still to be found. On the higher parts of the ridges or swells Laurentian boulders are not unfrequently met with.

General Physical and Climatic Features of the Peace River Country.

Peace River basin.

As the district of country defined on page 46 B, to the description of which the succeeding pages up to this point have been devoted, is bounded to the south by the Athabasca, it may be well here briefly to review the character of this great tract of the Peace River basin, and discuss what facts we possess as to its climate. As already noted its area is about 31,550 square miles. Its average elevation may be stated as a little over 2000 feet, and this is maintained with considerable uniformity, for though the general surface slopes slightly from the north and south toward the Peace River, the region as a whole may be considered as a plateau, through which the great gorge-like valley of the Peace has been excavated. This valley has in general a depth of 600 to 800 feet below that part of the plateau bordering it, with a width of two or three miles from rim to rim. Its tributary streams, at first nearly on the plateau level, flow in valleys of continually increasing depth as they approach that of the Peace River. Those from the south-eastern portion of the region, rise either in the Rocky Mountains or near the Athabasca, the tributaries received by the latter stream, in this part of its course, from the north and north-west being—with the exception of the Baptiste—quite inconsiderable.

Ridges.

The ridges and hills by which this region is occasionally diversified, appear in all cases to be composed either of the generally soft rocks of the Cretaceous, or of arenaceous clays containing erratics and representing the boulder clays of the glacial period. These elevations are generally slight, and with exceedingly light and gradual slopes, the scarped banks of the streams constituting much more important irregularities. These ridges, however, often resemble detached portions of a higher plateau, and spread widely enough to occupy in the aggregate a considerable area, of which the soil is not so uniform in character as elsewhere. With these exceptions, the soil of the district may be described as a fine silt, resembling the white silts of the Nechacco basin previously referred to, and not dissimilar from the loess-like material

Soil.

constituting the subsoil of the Red River valley in Manitoba. This silt, at a short distance below the surface, is greyish or brownish in color, but becomes mixed superficially with a proportion of vegetable matter to a varying depth. It has evidently been deposited by a comparatively tranquil body of water not loaded with ice, probably toward the close of the glacial period, and has either never been laid down on the ridges and undulations above referred to, or has been since removed from them by processes of waste. As evidenced by the natural vegetation its fertility is great.

West of the Smoky River, both to the south and north of Peace River, there are extensive areas of prairie country, either entirely open, and covered with a more or less luxuriant growth of grass, or dotted with patches of coppice and groves of trees.

Prairie west of Smoky River.

The northern banks of the Peace River valley, are also very generally open and grassed, and parts of the valley of the Smoky and other rivers have a similar character. The total area of prairie land west of the Smoky River, may be about 3000 square miles. The remainder of the surface is generally occupied by second-growth forest, occasionally dense, but more often open and composed of aspen, birch and cottonwood, with a greater or less proportion of coniferous trees. Some patches of the original forest remain, however, particularly in the river valleys, and are composed of much larger trees, chiefly coniferous, among which the spruce is most abundant. Handsome groves of old and large cottonwoods are also to be found in some of the valleys. Where the soil becomes locally sandy and poor, and more particularly in some of the more elevated parts of the high ridges above described, a thick growth of scrub pine and spruce, in which the individual trees are small, is found; and in swampy regions the tamarac is not wanting, and grows generally intermixed with the spruce.

Forest.

Country east of Smoky River.

East of the Smoky River, and southward toward the Athabasca, the prairie country is quite insignificant in extent, the region being characterized by second-growth woods of the kind just described, which, on approaching the Athabasca, are replaced by extensive and well nigh impassable tracts of *brulé* and windfall, in which second-growth forest is only beginning to struggle up.

Tracts of poor land.

Though the prairies are most immediately available, from an agricultural point of view, the regions now covered with second-growth and forest, where the soil itself is not inferior, will eventually be equally valuable. The largest tract of poor land is that bordering the valley of the Athabasca on the north. This rises to an elevation considerably greater than most of the region to the north and west, and appears during the submergence to which the superficial deposits are due, to have been exposed to stronger currents which have prevented the deposi-

tion of the fine silt, causing it to be replaced by a coarser silt which passes in places into actual sand, and alternates with ridges of boulder clay. This region is also often swampy, and for a width of twenty to twenty-five miles on the trail from Sturgeon Lake to Athabasca is quite unsuited for agriculture, though still in many places capable of yielding good summer grazing when the forest has been completely removed by fire. To the northward, more particularly to the east of Smoky River, peaty and mossy swamps occupy part of the surface, and these may be regarded as permanently unsuited to agriculture.

Total area suited to agriculture.

There is also a sandy tract, though of small width, along the lower part of the Wapiti River near its junction with the Smoky. Deducting, as far as possible, all the areas known to be inferior or useless, with about twenty per cent. for the portions of the region under consideration of which less is known, the total area of land, with soil suited to agriculture, may be estimated as at least 23,500 square miles. In the absence of complete maps, such an estimate cannot be otherwise than very rough, but may serve to give some idea of the fact.

Origin of prairies.

Whatever theory be adopted, and may have been advanced, to account for the wide prairies of the western portion of America further to the south, the origin of the prairies of the Peace River is sufficiently obvious. There can be no doubt that they have been produced and are maintained by fires. The country is naturally a wooded one, and where fires have not run for a few years, young trees begin rapidly to spring up. The fires are, of course, ultimately attributable to human agency, and it is probable that before the country was inhabited by the Indians it was everywhere densely forest-clad. That the date of the origin of the chief prairie tracts now found is remote, is clearly evidenced by their present appearance, and more particularly by the fact that they are everywhere scored and rutted with old buffalo tracks, while every suitable locality is pitted with saucer-shaped 'buffalo wallows.' In its primitive state, the surface was probably covered with a dense and heavy growth of coniferous trees, principally the spruce (*Picea Engelmanni* and *P. alba*) but with scrub pine (*Pinus contorta*) in some localities, and interspersed with aspen and cottonwood. These forests having been destroyed by fire, a second growth, chiefly of aspen, but with much birch in some places, and almost everywhere a certain proportion of coniferous trees—chiefly spruce—has taken its place. The aspen being a short-lived tree, while the spruce reaches a great age and size, the natural course of events, if undisturbed, would lead to the re-establishment of the old spruce forests.

Country originally forested.

Luxuriant vegetation.

The luxuriance of the natural vegetation in these prairies is truly wonderful, and indicates, not alone the fertility of the soil, but the occurrence of a sufficient rainfall.

With regard to the climate of the Peace River country, we are without such accurate information as might be obtained from a careful meteorological record, embracing even a single year, and its character can at present be ascertained merely from notes and observations of a general character and the appearance of the natural vegetation. Climate and agriculture.

It may be stated at once that the ascertained facts leave no doubt on the subject of the sufficient length and warmth of the season, to ripen wheat, oats and barley, with all the ordinary root crops and vegetables, the only point which may admit of question being to what extent the occurrence of late and early frosts may interfere with growth. This remark is intended to apply to the whole district previously defined, including both the river valleys and the plateau.

The summer season of 1879 was an unusual one, characterized by excessively heavy rainfall, with cold raw weather in the early summer months. These conditions did not extend to the west of the Rocky Mountains, but appear to have been felt over the entire area of the plains to the Red River valley. As a result of this, the crops generally throughout the North-west were later than usual, and the mean temperature of even the latter part of the summer appears to be rather abnormally low. Notwithstanding this, on my arrival at Dunvegan, on the 16th of August, small patches of wheat and barley in the garden of the fort presented a remarkably fine appearance and were beginning to turn yellow. On my return to the fort on August 31st these were being harvested, their complete ripening having been delayed by overcast and chilly weather which prevailed between these dates. At the first-mentioned date potatoes were quite ripe, with the balls formed on the stalks, and the garden contained also fine cabbages, cauliflowers, beets, carrots, onions, lettuce and turnips. Dwarf beans, cucumbers and squashes were also flourishing, and though these plants are particularly tender, showed no sign of frost. The two last-named having been sown in the open ground did not appear likely to perfect their fruit. A few stalks of Indian corn were also growing, though it is improbable that this cereal would ripen in this district. Summer of 1879. Crops at Dunvegan.

When this garden was again visited, on the last day of August, the beans, cucumbers and squashes had been cut down by frost, but not completely killed. The potato tops were also slightly nipped. Frosts.

Rev. Mr. Tessier, who has been at Dunvegan as a missionary for some years, has always been able to ripen small, black butter-beans, but in some seasons not without difficulty owing to frosts. He had also tried a few grains of oats which he procured accidentally, and obtained a return of astonishing abundance. About the date just referred to the potato plants at Smoky River post (The Forks) were badly cut down by frost, the tubers being, however, quite ripe, fine and large.

Crops at Lesser Slave Lake.

On the 15th September, Mr. R. McConnell, found the potatoes in the garden of the fort at the west end of Lesser Slave Lake, and on the level of the plateau, little affected by the frost, with tubers large and ripe. Mr. H. J. Cambie also ascertained that wheat thrives at this place. We found some rude attempt at cultivation also at the 'Cree Settlement,' previously referred to, which is at the average level of the plateau, with an elevation of about 2000 feet. Here, on September 14th, the potato plants were slightly affected by frost, but not more so than observed at Dunvegan two weeks before. The tubers were quite ripe, but the Indians did not intend to dig them for about ten days. Turnips were very fine, and carrots, beets and onions were good, though evidently cultivated with very little care. Two or three very small patches of barley had been almost completely destroyed by mice, but a few stalks remaining were quite ripe and with fine heads. The Indians here were very anxious to have a supply of garden seeds, which I have since been able to forward to them by the kindness of Messrs. Stobart, Eden & Co., of Winnipeg.

Indian gardens.

Climate at Fort St. John and Hudson's Hope.

At Fort St. John, ninety-five miles west of Dunvegan, and so much nearer the mountains, on July 26th, 1875, Professor Macoun states that potatoes, oats, barley, and many varieties of vegetables were in a very flourishing state in 'Nigger Dan's' garden. The oats stood nearly five feet high, and the barley had made nearly an equal growth.* The barley and oats were both ripe about the 12th of August. Prof. Macoun was informed by Charlette at Hudson's Hope, thirty miles further west, that in 1874 there was no frost from the 1st of May until the 15th of September. In 1875 sowing commenced the last week in April. There appears to have been a frost on June 28th, but the first autumn frost occurred on the 8th of September, and Mr. Selwyn found the potato tops still green in the middle of the month. Mr. H. J. Cambie saw wheat flourishing here in July last, but on his return in September it had been cut down by frost.

Length of winter.

Such are the notes that can be obtained on the growth of cereals and vegetables in the district in question. From information obtained at Dunvegan, it seems that the snow disappears about the middle of April, westerly winds sweeping it away fast. The river opens at about the same time. Cultivation begins at about the end of April or first of May. The river generally begins to freeze in November. The depth of snow, I was told, averages about two feet, an estimate which agrees with Mr. Horetzky's statement.† Mr. Horetzky was also told that the plains were often nearly bare up to the month of December, though the winter usually sets in with the month of November. Sir

* Report of Progress, Geol. Survey of Canada, 1875-6, p. 154.

† Canada on the Pacific, p. 205.

Alexander Mackenzie remarked the same absence of snow in the early winter months of 1792. It was entirely gone on April 5th, 1793, and gnats and mosquitoes were troublesome on April 20.* Horses almost invariably winter out well without requiring to be fed. Hay should be provided for cattle, to ensure perfect safety, for a period of three or four months, though in some seasons it is necessary to feed the animals for a few weeks only. The Indians of the 'Cree Settlement' on Sturgeon Lake, previously referred to, winter their horses without any difficulty round the borders of a neighbouring lake, the shores of which are partly open. From Hudson's Hope, the horses are sent southward to Moberly's Lake to winter, and according to Mr. Selwyn, do well there. Lesser Slave Lake, with its wonderful natural meadows, has long been known as an excellent place for wintering stock, and is referred to as such by Sir J. Richardson.

Wintering stock.

Some general idea of the length and character of the seasons at Fort St. John may be gained by an examination of the extracts from the journals from 1866 to 1875, published by Mr. Selwyn.† The dates of opening and closing of Peace River, being an important clue to the mean temperature of the region, may be quoted as summarized by Prof. Macoun in the same report (p. 156):

Opening and closing of river.

Ice breaking			Ice drifting, first time
1866	April	19	Nov. 7.
1867	"	21	" 8.
1868	"	20	" 7.
1869	"	23	" 8.
1870	"	26	no record.
1871	"	18	" 10.
1872	"	19	" 8.
1873	"	23	" 4.
1874	"	19	Oct. 31.
1875	"	16	

The average date of the breaking up of the ice may thus be stated to be April 21st; that on which ice is running in the river for the first time, November 7th. In 1792-3, when wintering at the mouth of Smoky River, Sir Alexander Mackenzie observed the ice to be running for the first time on November 6th, while the river was clear of ice on the 25th April. I have been unable to find any precise records of the dates of closing and opening of the Saskatchewan, but Dr. Hector states these are usually the second week of November and the second week of April, respectively. The Saskatchewan is a more rapid stream than the Peace.

Average.

* Voyages, p. 131-132.

† Report of Progress, Geol. Survey of Canada, 1875-76, p. 84.

Valley and plateau compared.

With regard to the probable difference between the actual valley of the Peace, and the plateau forming the general surface of the country, Prof. Macoun observes,* speaking of the vicinity of Fort St. John, that notwithstanding the difference in altitude, the berries on the plateau ripened about a week only later than those near the river, while he was informed that there was about the same difference in the time of disappearance of the snow in spring. While at Dunvegan, I ascertained that a similar difference was observed there, but it was added that this obtained chiefly with the wooded parts of the plateau, the snow disappearing on the prairies much about the same time as in the valley. In my diary, under date September 5th, I find the following entry :— " Aspens and berry bushes about the Peace River valley now looking quite autumnal. On the plateau, 800 or 900 feet higher, not nearly so much so. Slight tinge of yellow only on some aspen groves." This difference, though not altogether constant and depending much on diversity of soil, appears to be actual. In October, 1872, Mr. Horetzky writes : ‡ " We observed that, curiously enough, the vegetation upon these uplands did not appear to have suffered so much from the effects of frost, this being probably due to the fact of the air in these upper regions being constantly in motion, while in the deep and capacious valley of the river the winds have often no effect."

Observed temperatures.

The difference between the valley and the plateau being thus very small, I have not treated separately the observations for temperature taken by myself in the different situations. Most of the observations, however, refer to the plateau; and including the whole time spent in the country, from the Middle Forks of Pine River to the bank of the Athabasca, cover a period of nearly two months. The mean minimum temperature for the month of August, deduced from observations extending from the 6th to the 31st of the month, is 39·9°. The mean of observations at 6 a.m. during the same period is 42·3°. That of the observations at 6 p.m., 59·5°. In September the mean minimum temperature was 28·1°. The mean of morning observations 34·3°, of evening observations 51·5°. I have endeavoured to deduce from these observations mean temperatures for the months in question, by correcting them by the tables of hourly variations in temperature given by C. A. Schott in the Smithsonian Contributions to Knowledge (No. 277), but find it impossible to do so, as the daily range is here so much greater than that of any of the places represented by the tables, which refer chiefly to the eastern portion of the continent. It would appear, that while in most places the mean temperature of the day is reached

* *Op. cit.*, p. 155.

‡ Canada on the Pacific, p. 44.

about 8 p.m., it is found in the Peace River country not far from 6 p.m., by reason of the increased rapidity of loss of heat by radiation due to greater elevation and dryer atmosphere. The maximum temperature was seldom observed, but the daily range is very great, and the maximum probably several times reached 80° in August, and often surpassed 70° in September.

From the 6th to the 31st of August I registered two nights of frost, on the 13th and 20th of the month, when the thermometer showed 32° and 26°, respectively. Both of these were observed on the plateau, but one at least of them (that of the 20th) must have occurred also in the valley, from the effects produced at Dunvegan on tender vegetation. These frosts occurred in very fine weather, following a day of strong westerly wind, the result of which is to remove from the surface of the earth the whole of the lower heated layer of the atmosphere. This, succeeded by a calm and cloudless night with transparent sky, causes the thermometer to sink below the freezing-point before morning. When not preceded by strong wind, mere transparency of the atmosphere seems seldom or never to lead to frost in August, in this district, as many beautifully starlight nights without an approach of the mercury to the freezing-point were experienced. Frosts registered.

Though in some cases such frosts as these may be general, and extend over a wide district of country, it is more usually found that they are quite local in character. A few floating clouds, or light wreaths of mist, may arrest radiation so far as to prevent frost over the greater part of the country, while some spot accidentally exposed during the whole night under a clear sky, experiences a temperature below 32°. The contour, and character of vegetation of the country, also have much to do with the occurrence of frosts, and it is very frequently the case that river valleys are more subject to frosts than the upland districts. During the month of September, in a region for the most part wooded, and often above the average altitude, between Dunvegan and the Athabasca, nineteen frosts were registered, the actually lowest temperature being 20° on September 18th.

Through the kindness of Colonel Jarvis, of the North-west Mounted Police, I have been able to secure a copy of records kept by Dr. Herchmer, of Fort Saskatchewan, on the Saskatchewan River, about twenty miles north-east of Edmonton. For comparison with the observed temperatures in the portion of the Peace River country now discussed, they are invaluable; for in the whole district surrounding Fort Saskatchewan and Edmonton we now know, from actual and repeated experiment, that wheat and all other ordinary cereals and vegetables thrive, and yield most abundant crops. The climate, in its great diurnal and annual range, corresponds exactly with that of the Peace Comparison with Fort Saskatchewan.

River country. Fort Saskatchewan is situated on the brow of the Saskatchewan valley, about seventy feet above the river, and therefore probably less liable to frosts than either the bottom of the river valley or extensive flat tracts of plain, where there is little circulation of air. This, with the position of the thermometers in regard to the buildings, leads to the belief that if at all in error, as representing the climate of the region generally, the indicated temperatures are slightly too great. The thermometer appears to have been read in all cases to the nearest degree only.

A comparison may be made between the temperatures observed in the Peace River country during August and September, with those at Fort Saskatchewan, as follows:—

Peace River country,	mean of minima during	August	39·9°
"	" "	September	28·1°
"	frosts experienced during	August	3
"	" "	September	19
Fort Saskatchewan,	mean of minima during	August	39·3°
"	" "	September	31·1°
"	frosts experienced during	August	0
"	" "	September	15
"	mean of maxima during	August	77·8°
"	" "	September	68·1°
"	deduced mean temp. of	August	58·6°
"	" "	September	49·6°

Means.

The mean of maxima and actual mean temperature for the months cannot be stated for the Peace River country. The actual mean for Fort Saskatchewan is obtained by adding the minima and maxima for each month together, and is probably very nearly correct.

General conclusion.

While regretting that the data at disposal for the determination of the agricultural value of the Peace River country are not fuller, we may, I believe, arrive with considerable certainty at the general fact that it is great. From such comparison as can be made, it would be premature to allow that the climate of the Peace River is inferior to that o the region about Edmonton on the Saskatchewan. It is true that in both the Saskatchewan and Peace River districts the season is none too long for the cultivation of wheat, but if the crop can be counted on as a sure one—and experience seems to indicate that it may—the occurrence of early and late frosts may be regarded with comparative indifference. The season is at least equally short throughout the whole fertile belt from the Peace River to Manitoba, though early and late frosts are not so common in the low valley of the Red River. The almost simultaneous advance of spring along the whole line of this fertile belt, is indicated by the dates of the flowering of the various

plants, a point referred to by me in some detail elsewhere.* It is further unquestionable that the winter is less severe, and not subject to the same extremes in the Peace River and Upper Saskatchewan regions as in Manitoba.

We have already found reason to believe that the early and late frosts, and not the absence of a sufficient aggregate amount of heat, constitute the limiting condition of wheat culture in the North-west; but that neither the Saskatchewan nor the Peace River countries lie upon the actual verge of the profitable cultivation of wheat, appears to be proved by the fact that oats succeed on the Saskatchewan, and also —in so far as one or two seasons can be accepted as evidence—on the Peace River; while it is well known that this cereal is less tolerant of summer frost than wheat. This is further proved by the fact that at Fort Vermilion and Athabasca Lake, 180 and 300 miles, respectively, north-east of Dunvegan, Prof. Macoun found wheat and barley ripening well; but in this instance the fact is complicated by the circumstance of the decreasing altitude of the country, which introduces a new condition. As no knowledge has been gained of this country on the Lower Peace in addition to that collected by Prof. Macoun in 1875,† it is not included in the above discussion, though from it additional great areas might doubtless be added to the fertile tract.

Limiting conditions of agriculture.

Lower Peace.

Referring to the journals kept at Fort St. John, Mr. Selwyn, in the report already several times referred to, comes to the conclusion that the climate of the Peace River compares favourably with that of the Saskatchewan or Montreal.

To give some idea of the value of a tract of generally fertile country such as that now described, let us assume, as above, that the area of actually cultivable land is 23,500 square miles, or 15,140,000 acres. Let us suppose, for simplicity of calculation, that the whole area were sown in wheat, the yield, at the rate of twenty bushels to the acre, would be 300,800,000 bushels.

Possible wheat product.

The portion of the Peace River country embraced in the explorations of 1879, and treated of in this report, however, by no means includes the whole fertile tract, as the statements made regarding the lower part of the Peace by Prof. Macoun‡ and others show. Sir J. Richardson places the northern limit of the profitable cultivation of wheat in the Mackenzie valley, at Fort Liard, on the Liard River (lat. 60°5′ N.), while from trustworthy information obtained by Prof. Macoun, it appears that even at Fort Simpson, on the Mackenzie in lat. 61° 51′, wheat succeeds

Northern limit of agriculture.

* Geology and Resources of the 49th Parallel, 1875, p. 279.

† Report of Progress Geol. Survey of Canada, 1875-76.

‡ Report of Progress Geol. Survey of Canada, 1875-76.

four times out of five, and barley always ripens from the 12th to the 20th of August.

Observations at Fort Simpson.

In the report of the Meteorological Department for 1876, a series of observations taken by Mr. J. S. Onions at Fort Simpson is printed. This, though extending merely from May to November, 1875, seems to show that the climate compares very favourably with that of the Upper Peace River. No frosts occurred from the 18th of May to the 10th of September. The mean temperatures of the months of growth are as follows, the figures in the first column being from the source just alluded to, those in the second from the appendix to Sir J. Richardson's "Journal of a Boat Voyage":—

	I.	II.
	°	°
May	44·6	48·16
June	58·8	63·64
July	63·5	60·97
August	63·2	53·84
September	44·8	49·10

The figures differ considerably, but those under column I. are probably the more accurate, as the second series depends on observations taken at 8 a.m. and 8 p.m., to which a correction of the kind previously mentioned as inappliable to this western region, has been applied.

Influence of warm winds.

It has often been stated, in a general way, that the cause of the exceptionally favourable climate of the Saskatchewan and Peace River countries, as compared with that of the eastern portion of the American continent, is to be found in the prevalence of warm westerly winds from the Pacific. Sir Alexander Mackenzie speaks of these westerly winds in winter, writing: "I had already observed at Athabasca, that this wind never failed to bring us clear mild weather, whereas, when it blew from the opposite quarter, it produced snow. Here it is much more perceptible, for if it blows hard south-west for four hours a thaw is the consequence, and if the wind is at north-east it brings sleet and snow. To this cause it may be attributed that there is so little snow in this part of the world. These warm winds come off the Pacific Ocean, which cannot, in a direct line, be very far from us, the distance being so short that, though they pass over mountains covered with snow, there is not time for them to cool.*

Extract from Mackenzie.

Chinook winds.

Further south, these south-westerly currents are known as 'Chinook winds,' and similar consequences are observed to follow their occurrence. Sir Alexander Mackenzie, however, in the summer of 1793, found the distance to the Pacific coast from his wintering place at the mouth of Smoky River, greater than he appears to have imagined at

* Voyages, p. 138.

the time he penned the above-quoted remarks, and it is difficult indeed, to understand how currents of air, blowing for at least 350 miles across a country which is for the most part mountainous, should retain enough warmth to temper effectually the climate of the plains to the east. This difficulty would appear to be particularly great in summer, when the mountains are largely snow-clad, and the mean temperature of the Peace and Saskatchewan valleys, is probably considerably in excess of that of the region intervening between them and the sea.

Explanation of the phenomenon.

The complete explanation is to be found in the great quantity of heat rendered latent when moisture is evaporated or air expanded in volume, but which becomes sensible again on condensation of the moisture or compression of the air.

Air cooled by expansion.

The pressure in the upper regions of the atmosphere being so much less than in the lower, a body of air rising from the sea-level to the summit of a mountain range, must expand, and this, implying molecular work, results in an absorption of heat and consequent cooling. The amount of this cooling has been estimated at about 1° Centigrade for 100 metres of ascent when the air is dry, but becomes reduced to ½ degree when the temperature has fallen to the dew-point of the atmosphere, and precipitation of moisture as cloud, rain or snow begins; the heat resulting from this condensation retarding to a certain degree the cooling due to the expansion of the air. When the air descends again on the further side of the mountain range, its condensation leads to an increase of sensible heat equal to 1° C. for each 100 metres.* It is owing to this circumstance that places in the south of Greenland, on the west coast, during the prevalence of south-easterly winds, which flow over the high interior of the country, have been found, in winter, to experience for a time a temperature higher than that of North Italy or the south of France, though the North Atlantic Ocean from which the winds come, can, at this season, be little above the freezing-point. The wind well known in the Alps as the foehn, is another example of the same phenomenon.

Heated by condensation.

Examples.

Hypothetical case of the West Coast.

The data are wanting for an accurate investigation of the circumstances of our west coast in this regard, but a general idea of the fact may be gained. We may assume that the air at the sea level is practically saturated with moisture, or already at its dew-point, that in crossing the mountainous region the average height to which the air is carried is about 2000 metres (6560 feet), and that it descends to a level of about 700 metres (2296 feet) in the Peace River country. The loss of sensible heat on elevation would, in this case, amount to 10° C.

* The figures are Dr. Hann's, quoted by Hoffmeyer in the Danish Geographical Society's Journal, and reproduced in Nature, August, 1877.

(18° F.), the gain on descent to the level of 700 metres to 13° C. (23·4° F.). The amount of heat lost by the air during its passage across the mountainous region, by radiation and contact with the snowy peaks, cannot be determined. It is of course much greater in winter than in summer, and depends also on the speed with which the current of air travels. Taking the mean summer temperature of the coast at about 12° C. (54° F.) and allowing several degrees for loss by radiation, it becomes easy to understand how the western prairies may be flooded with air nearly as warm as that of the coast, though it has travelled to them over a region comparatively cold.

Affected by local circumstances.

Owing to the great width of the mountain barrier, the main result is complicated by local details, regions of considerable precipitation occurring at each important mountain range, with subsidiary drier regions in the lee. The last of these regions of precipitation is that of the Rocky Mountain Range properly so-called. In descending from this, a further addition of heat is made to the air, which then flows down as a dry and warm current to the east.

Effect of long summer days on vegetation.

In addition to the favourable climatic conditions indicated by the thermometer, the length of the day in summer in the higher northern latitudes favours the rapid and vigorous growth of vegetation, and takes the place to a certain extent of heat in this respect. This has been supposed to be the case from the luxuriant vegetation of some northern regions, but Alfonse de Candolle appears to have put the matter beyond doubt by subjecting it to direct experiment. In latitude 56° which may be taken as representing the position of much of the Peace River country, sunrise on the 21st of June, occurs at 3h. 12m., sunset at 8h. 50m.; while six degrees further south, in latitude 50°, which may be assumed to represent Manitoba, sunrise occurs on the same day at 3h. 49m., sunset at 8h. 13m. The duration of sunlight is, in the first case, 17h. 38m.; in the second, 16h. 24m., or one hour and a quarter in excess in the northern locality. This excess of course decreases to zero at the spring and autumn equinoxes, and the difference is reversed in the winter.

Length of sunlight on Peace River.

Effect of prolonged daylight in North Europe.

In further illustration of this point, the following extracts from a note in the American Journal of Science, vol. xx., p. 74, may be cited:— "It is well understood that for a plant to complete its development and mature its seeds, a certain sum of heat is required, varying according to the species. It appears,—as indeed might antecedently be expected,—that we should rather say a certain amount of solar radiation; for light, to a certain extent, may replace temperature. This is shown in the effects of almost uninterrupted summer sunshine upon vegetation in high latitudes. According to Schübeler of Christiana and others, barley ripens in eighty-nine days from the sowing in

Finland, while it requires one hundred days in the south of Sweden, though the latter enjoys a considerably higher temperature. A grain of wheat grown at nearly the sea level in Norway, or in lower latitudes, when propagated at high elevations or in a high latitude, will mature earlier, even although at a lower temperature; and it is said that, within limits compatible with its cultivation the grain increases in size and weight."

"Schübeler also makes out that grain, after several generations of cultivation in the highest latitudes or the highest elevations compatible with its cultivation, will when transferred back to its original locality ripen earlier than grain which has not been moved. But it loses this precocity in a few generations, and the seeds gradually diminish to the former size and weight. Plants raised from seeds ripened in a high northern locality are hardier than those grown in the south, and are better able to resist excessive winter cold."

Immunity of Peace River from the locust.

A further circumstance giving to the Peace River country and that on the upper part of the Saskatchewan, other things being equal, a value as farming land acre for acre considerably greater than that of most parts of the North-west, is the immunity of this region from the visits of the devastating locust or grasshopper (*Caloptenus spretus*). I have elsewhere discussed the question of locust invasions, in several papers,* and it has since been taken up by the United States Entomological Commission.† It must suffice to state here, that while long series of years may pass without the occurrence of serious invasions, these must continue always, or at least for a very long time, to constitute a drawback to the whole territory lying south of a line drawn about sixty miles south of Edmonton, and thence nearly following the border of the wooded country southward and eastward to Manitoba.

The Athabasca River from Drift-pile Camp to Lesser Slave River.

Name of the river.

The Athabasca River derives its name from the great lake into which it flows, which is called A-pĕ-pas-kow by the Crees. The upper part of the river is known as Mus-ta-hi-sī-pī or Great River.

Efforts to communicate with party from Edmonton.

On reaching its north bank on our traverse from Sturgeon Lake, Mr. MacLeod and I had arranged to separate, Mr. MacLeod continuing on overland toward Dirt Lake, while I intended to make a canoe and descend the river. As no traces had yet been found of the party which was supposed to be on the way from Edmonton to meet us, we now set fire to a great pile of drift-logs on one of the bars, and sent one Indian

* Canadian Naturalist, Vol. VIII., pp. 119, 207, 411.

† First Annual Report, United States Entomological Commission, 1878.

up and another down the river to seek for information, but all with no result. It was further unexpectedly found that no cottonwood trees suitable for making a canoe existed in the valley, and as the river was evidently quite unsuited to be descended on a raft, by reason of its swiftness and the number of shoal bars which occur now on one side and now on the other, it became difficult to know in what way the programme could be carried out. It was finally decided to use the canvass cargo-covers and blanket wrappings in the construction of a canoe. To this all hands devoted themselves for three days, when we had the satisfaction of seeing a large canoe, properly framed and strengthened, which when painted over with a mixture of bacon fat and spruce gum was nearly water-tight. I had great difficulty in persuading our last Indian guide, Antoine, to accompany me down the river, which he was supposed to know something about having worked Hudson Bay boats on it many years ago. Having at last induced him by offers of good remuneration to accompany us, and having waited a day till he provided himself with a sufficient supply of moccasins for the return journey, we set out on our descent of the river on September 30th. Mr. MacLeod and I had previously divided the provisions still remaining, finding about twenty days supply for each party, which we hoped would be sufficient to carry us to Edmonton. Besides myself the occupants of the canoe were W. McNeil of Victoria, Antoine, a Cree Indian, with whom we could not converse, and his little son, about twelve years old.

Build a canvass canoe.

Engage a guide

The Athabasca formerly a trade route.

The Athabasca River was formerly much used by the Hudson Bay Company as a route to Jasper House, and thence across the Rocky Mountains to the Boat Encampment on the Columbia, but is now abandoned as a trade route. Dr. Hector followed the upper part of the river from Old Fort Assineboine to Jasper House in January, 1859, and has given a sketch of it on the map accompanying Pallisier's Report.

Drift-pile Camp to the McLeod.

From our starting point, Drift-pile Camp, a few miles above the mouth of Marsh Head Creek, to the mouth of McLeod River, the Athabasca valley probably averages two miles in width from rim to rim, and is from 300 to 400 feet in depth, though the banks become somewhat lower and retire further from the stream near its confluence with the McLeod. The river itself is generally wide, shallow and very rapid, spreading among numerous gravelly bars and small islands. Extensive flats occur at heights of six to forty feet above the river, but the soil on these is evidently poor and sandy, though improving considerably in the lower part of that portion of the river now described, where also the scrub pine is found less abundantly, its place being taken by cottonwood groves. Low scarped banks with expo-

Plate 6.

G. M. D., Photo. Sept. 26, 1879.

ATHABASCA RIVER AT DRIFT PILE CAMP, LOOKING DOWN.

sures of soft sandstone, shales and coals occur at intervals, and the sides of the valley though in general gently sloping and tree-clad, are occasionally steep and roughened by outcrops of sandstone. The floods on this part of the river seem seldom to rise higher than eight feet, and never to exceed ten.

Find a note from the Edmonton party.

In descending the river we were keeping a sharp lookout for traces of the party from Edmonton, and at length—nearly twenty miles below Drift-pile Camp—we noticed a newly blazed tree, and on landing found a note attached to it. This had been written by Mr. Brown, who stated that he had reached the river at this point on September 23rd, having travelled three days on foot from where they had left their horses in a region impassable from dense masses of fallen timber. Their supplies had also become exhausted, and it was intended to turn back at once for Edmonton. It was therefore fourtunate that we had not depended at all on the Edmonton party for supplies or assistance.

From the McLeod to Fort Assineboine.

The actual conflux of the McLeod River was not seen, as we passed it without notice among islands. We soon found that our guide had forgotton nearly all he had ever known about the river. East of the McLeod are some low hills which rise to 500 feet near the bank of the Athabasca, but are probably quite limited in extent. From this point to Old Fort Assineboine, a distance of thirty-three miles in a straight line, the river valley is on the whole narrower than before, and the banks lower, seldom seeming to exceed 200 feet in height. The river is characterized by the presence of numerous and large islands, which sometimes occupy nearly the whole width of the valley bottom, the stream spreading out and becoming very shoal. The current is at first rapid as before, but for some distance above Old Fort Assineboine is quite tranquil. The flats and flat land on the islands is in great part composed of fine silt and fairly well adapted for agriculture. About half the area of the flats is above the level of flood-water.

Fort Assineboine.

Old Fort Assineboine has been abandoned for many years, and not long ago the ruins of the building were destroyed by fire. Its site is now marked by a few irregular heaps of stones and charred wood. The flat on which it was situated is on the left or north bank of the river and is extensive.

Fort Assineboine to Lesser Slave River.

Six miles beyond the site of Old Fort Assineboine, the river turns suddenly to a north-eastward course, in which it continues with little deviation to the mouth of the Lesser Slave River. The plateau forming the general level of the country, appears to have an elevation of about 200 feet above the river for some distance below the old fort, but gradually declines till it is not more than 100. The banks at the same time lose to a great extent their escarpment-like character, and form gentle slopes on each side, or rise from the river in successive low

steps. The flats bordering the river are now, too, much narrower. The current of the river is slack, probably not averaging three miles an hour, and though there are occasional little rapids, there seems to be nothing to prevent navigation by a stern-wheel steamer. The banks are chiefly wooded with poplar second-growth. A few tamarac (*Larix Americana*) trees were observed here and there, and our guide informed us that pretty extensive tamarac swamps lay, in some places, on both sides of the river away from its immediate course.

Pembina River.

About half way from the old fort to the mouth of Lesser Slave River, the Pembina, or Mī-nī-pī-mī-nan-sī-pī, joins from the right. It is about 150 feet only in width at the mouth, but deep, and filled with clear brown water, very different in appearance from the muddy flood of the Athabasca.

Lesser Slave River and Lake.

Decide to ascend Lesser Slave River.

On arriving at the mouth of Lesser Slave River, on October 6th, I found a note which the Rev. Mr. Gordon had left there nearly a month previously, when on his way in the Hudson Bay boat to Athabasca Landing. I was anxious to hurry on to the Landing, as I was already late for my appointment with Mr. McConnell, and our canvas canoe was very poorly adapted for working up such a stream as the Lesser Slave. Finding however from Mr. Gordon's note that none of the parties from the east had reached this point, it became evident that a running survey of the Lesser Slave, and latitude of the outlet of the lake, would be necessary to fill the gap in the exploration of a route for railway purposes. We therefore applied ourselves to the task of ascending the river, which after four days of arduous labour, in cold stormy weather, we accomplished. The river, from its mouth to the lake, is about forty-one miles in length and very crooked. For eighteen miles from the mouth it forms a succession of rapids, which are shallow and stony. Of these there are about twenty in all. Above this the stream is tranquil, though still exceedingly crooked, and flows at the rate of about 1·7 miles an hour. In width the stream decreases from an average of about 200 feet on its lower part to 100 or even less in its upper. The banks near the mouth are about eighty feet high, and each covex bend of the river here forms a scarped slope, while the opposite side presents a flat, or series of low terraces often lightly wooded, but sometimes open and covered with fine grass. In ascending the stream the banks decrease in elevation, till near the lake they scarcely rise above the water level, and broad swamps with fine grass spread widely in all directions, and would afford vast quantities of excellent natural hay. The soil on the flats along the river is generally good, but these are quite inconsiderable in area. That of the general

Character of the river.

The banks and surrounding country.

surface of the country seems, however, to be equally good, though wide swampy areas are reported at a little distance back from the river. The character of the deposits shown in the banks indicates that Lesser Slave Lake has at one time spread much more widely, but that the rim of the basin containing it has been gradually cut through by the Slave Lake River. Ice marks produced in the spring floods were observed at a height of fifteen feet above the low water level on the lower part of the river. **Flood marks.**

Near Lesser Slave Lake, the river makes a loop several miles in circuit, to avoid which a portage of sixty-three yards may be made, across a neck of low ground.

Lesser Slave Lake is called A-yī-tī-ī-noo Sa-ga-he-gan by the Crees, and but imperfectly translated by the English name. A-yī-tī-ī-noo means a foreign Indian, and though here referring to some story connected with the Chepewayans to the north-east, is also used to designate the Blackfeet and other tribes by the southern Crees. The lake is a great expanse of water about seventy miles in extreme length, by fourteen miles in greatest width. It is evidently shoal throughout, and I was informed that there are only two places wrere the water is deep along shore. At the east end is a hard flat sandy beach, with sand ridges and low dunes behind it. The lake is bounded by high hilly country, at no great distance both to the north and south. The name of the highest point of the hills or ridge to the north was given to me as Raspberry Mountain. Those to the south are generally flat-topped, and resemble the remnants of a higher plateau, most of which has been removed by denudation. They probably average 500 to 600 feet in height above the lake, and may reach 1000 feet in some places. Additional particulars with regard to the lake will be found in Mr. McConnell's report. I had hoped to obtain photographs and sketches of it, but after waiting in a very uncomfortable camp during the afternoon of October 10th and morning of the 11th, with no abatement in the storm of wind with flurries of snow, which had begun on our arrival, decided to set out on our return. On the 12th we ran all the rapids safely, in a blinding snow storm, and camped early in the afternoon on the Athabasca, as the air was too full of snow to allow me to take bearings from point to point on the river. **Lesser Slave Lake.** **Descend Lesser Slave River.**

At the date of our visit the whole vicinity of Slave Lake was populous with wild fowl on their way southward—ducks of several species, geese, cranes and swans. **Wild fowl.**

Athabasca River from Lesser Slave River to Athabasca Landing.

Character of the river and banks.

From the mouth of the Lesser Slave River to Athabasca Landing, the Athabasca flows first for some miles to the north of east, and then takes a south-south-eastward course to the Landing. The distance by the river, which is here flexuous but not very crooked, is sixty-three miles. A rounded hill or ridge about three hundred feet high stands at the junction of the Lesser Slave and Athabasca Rivers, but the general level of the plateau for some distance below appears not to exceed two hundred feet. It gradually increases, however, till it reaches a height of 350 feet at the Landing. The current of the river probably averages about two miles an hour throughout, and there are several little rapids, where it spreads pretty widely and becomes somewhat shoal. All these might, however, I believe, be surmounted by a stern-wheel steamer at high water. No rock exposures are seen, and only occasional slides, most of which are of old date and show little appearance of recent movement. The flats are generally narrow and pass at a short distance from the water's edge into the slopes of the valley. These are almost everywhere light, seldom exceeding 15° and often about 10° only. No hills rising above the general level of the plateau were seen in any direction.

Aspect as a railway route.

In its aspect as a possible railway route, the following points may be noted of the country between Slave Lake and Athabasca Landing. From Slave Lake, which appears to present every facility for the passage of a railway along either shore, the best line would follow the south side of the Lesser Slave River, not in the immediate valley, but on the edge of the plateau bordering it. At the mouth of the river, the Athabasca might be crossed by a bridge 760 feet long and about forty feet high, with excellent approaches. From this point it would probably be best to follow the right side of the Athabasca valley, notwithstanding its somewhat sinuous course, to the Landing, when the summit of the plateau could be gained without difficulty by the valley of the Tow-ti-now-sī-pī, which enters there. The bank of the Athabasca, as indicated by the description previously given, is favourable, and no heavy slides occur in this portion of its length. A line taking the north bank of the river would have to cross the Lesser Slave River near its mouth, with a bridge of 150 to 200 feet long, and might cross to the south side of the Athabasca at the Landing, with a bridge of 912 feet, with good approaches. Owing to the uniform character of the banks of the valley, it would also be possible to gain the level of the plateau without necessitating very heavy work, at several intermediate points.

Plateau south of the Athabasca.

The character of the plateau lying immediately south of the Athabasca is probably favourable, and there are few streams of any size

joining the river in this part of its course. An extensive view from the highest point of the plateau above the Landing shows a nearly level horizon in every direction, its uniformity being broken only by a few low ridges many miles distant.

A railway line from Lesser Slave Lake to Lac La Biche could be made more direct, by cutting across the V-shaped bend of the Athabasca which has its apex at the Landing. No impediments to such a line in the way of hills or high ground were seen, either from the banks above the mouth of Lesser Slave River or from the point at the Landing just referred to. The Moose River joins the Lesser Slave thirteen and a half miles from its mouth, coming from the eastward, and appears to be a sluggish stream about eighty feet wide. I was informed by Indians that this river can be ascended in small canoes, numerous portages being necessary on account of jams of drift-wood. A portage of about two "spells," (say two miles) leads then over low ground to the Calling River, by which one may descend to the Athabasca, reaching it some miles below the mouth of the Rivière La Biche. There is also a trail by which the Indians take horses from the east end of Lesser Slave Lake to the Athabasca, near the point just indicated; and it is said, that from points near the Rivière La Biche the Raspberry Mountain, on the north shore of Lesser Slave Lake, may be seen, the intervening country being all comparatively low. A reference to Mr. McConnell's report on the Athabasca below the Landing, will show that it runs westward for some miles below the entrance of the Rivière La Biche, and affords facilities for the descent of a railway line to the river level which would probably render it unnecessary to follow the Calling River down to its mouth. **Route by Moose and Calling Rivers.**

Athabasca Landing to Edmonton.

On arriving at Athabasca Landing, on October 14th, I found that Mr. McConnell with the pack animals had been waiting there some days. To reach the Landing he had been obliged to go from the east end of Lesser Slave Lake to Old Fort Assineboine, and then to Edmonton. The weather was now cold and wintry, with several inches of soft snow on the ground, and the time appointed for the rendezous at Edmonton at hand, while the practicability of the Rivière La Biche or Wa-was-ke-soo-sī-pī for railway purposes, remained to be determined. We were so fortunate as to find a free-trader at the Landing, with a boat, about to set out on his last trip to Lesser Slave Lake with goods, and from him were able to purchase a small bark canoe, with which we were assured the ascent of the Rivière La Biche might be accomplished. The canvas canoe was left in a shed belonging to the Hudson Bay Company, and on the 15th Mr. McConnell, with a half-breed named **Arrangements for completing surveys.**

Adam Caillon, left the Landing to descend the Athabasca, ascend the Rivière La Biche, and make the best of his way to Victoria or Edmonton after reaching the Lac La Biche settlement. No time was to be lost, as the small river might now at any time become partly choked with ice and impassible for the canoe. The weather turning clear and cold on the night of the 15th, enabled me to obtain observations for latitude, and on the morning of the 16th I set out for Edmonton with the pack animals.

Road to Edmonton.

From Edmonton to the Athabasca Landing the Hudson Bay Company has constructed a rough cart-road to facilitate the transport of their goods toward Lesser Slave Lake and Peace River. Edmonton is nearly due south of the Landing, at a distance of eighty-three miles in a straight line, or about ninety-six miles by odometer.

Country south of Landing.

On leaving the Landing the trail to Edmonton follows the Tow-ti-now sī-pī southward for about thirty-two miles. Eight miles further on the road crosses a shallow creek which unites the Bridge Lakes. The valley of the Tow-ti-now runs nearly direct, and is wide and deep, though the sides are often a little lumpy and irregular. With the exception of limited areas in the valley, the whole country has been burnt over, and is strewn with logs, among which shrubby second-growth is appearing. Fine grass and pea-vine appears everywhere, and the country would be a good grazing one, though the soil is generally sandy, and on the plateau there are numerous boulders, often packed closely together, and generally of Laurentian origin. Fairly good soil is seen in a few spots. The surface of the plateau shows a tendency to arrangement in north and south trending ridges, parallel in a general way to the valley of the stream. The Banksian pine is now found in abundance, replacing the western scrub pine. It is much less symmetrical in habit of growth than the latter, with more numerous and diffuse branches and a thicker and rougher bark.

Banksian pine.

Watershed.

From Bridge Lakes, with an approximate elevation of 2415 feet, the road gradually ascends, and in a few miles crosses the watershed between the streams flowing direct to the Arctic Ocean and those going to Hudson Bay. This does not rise much above the general level, having an altitude of about 2485 feet, and though resembling a range of low hills from a distance, is found on approach to have very light slopes. It is an undulating sandy tract of country which has probably been shaped by currents during a general submergence, and shows a tendency to the arrangement of its features in a north-west and south-east bearing. It is lightly wooded with Banksian pine and poplar. A small brook soon leads to the Vermilion River or Wī-a-mīn-sī-pī of the Crees, which occupies a wide shallow valley and is a sluggish winding stream about thirty-five feet in width. Its approximate elevation is 2105 feet.

South of the Vermilion the trail crosses an indistinct low undulating watershed, and passing Long Lake follows the stream which flows from it to the Sturgeon River. South of the Vermilion the country assumos a distinctly prairie aspect. The surface is covered with short close grass, and groves of willow and poplar are chiefly confined to the valleys. Many old buffalo trails and wallows appear, and a few scattered buffalo bones were observed, though no traces of this animal were noticed north of the Vermilion. This prairie has probably been produced by fire, but is of much older date than the grassy country to the north, wich is still in process of denudation by successive fires. The land between the Vermilion and the Sturgeon is of fairly good quality with a great admixture of vegetable mould.

Edge of prairie country.

The Sturgeon River also occupies a wide shallow valley, but is a much larger stream than the Vermilion, averaging sixty feet wide by one deep. In Cree the Sturgeon is called Mī-koo-kī-pow-sī-pī, or Red Willow River. The surface from the Sturgeon to the Saskatchewan may be described as a gently undulating prairie of uniform fertility, with a deep black loamy soil, yet light enough to be warm and easily worked. Belts of aspen with coppice of willows vary the monotony, and occasional swamps with fine natural hay occur. The surface declines gradually toward the Saskatchewan valley. Where crops have been tried, wonderfully favourable returns have been obtained.

Sturgeon River to Edmonton.

Edmonton and its vicinity having been frequently noticed by previous travellers, and its lignite coal deposits described by Mr. Selwyn * and Dr. Hector, it will not be necessary to speak of it here. It may be stated, however, that on this part of the Saskatchewan there lies an extensive region of very great fertility, in which settlement is already advancing, and which possesses all the elements necessary to enable it to become, at some not very distant date, a populous province of the Dominion.

Edmonton.

Edmonton constituted the terminal point of our surveys for the season. Mr. MacLeod arrived by land from the Upper Athabasca on the same day that I reached the Fort from the Landing. We were now joined also by Mr. Tupper's party, which had fallen back on Edmonton after their unsuccessful attempt to meet us. After a few days spent in making the necessary arrangements and selecting the strongest of the animals, we set out, on October 25th, on our journey of 900 miles to Winnipeg. The combined parties now numbered fifteen men, thirty-four horses and mules, eight Red River carts and two buck-boards. At Duck Lake, on November 12th, the carts were exchanged for flat-sleds, a heavy fall of snow having taken place, and on the 2nd of December,

Journey to Winnipeg.

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*Report of Progress Geol. Survey of Canada, 1873-74.

after a wintry journey of thirty-eight days across the plains, we were glad to find ourselves at Winnipeg and again within hearing of a railway whistle.

DESCRIPTION OF THE COUNTRY FROM THE CONFLUENCE OF THE SMOKY AND PEACE RIVERS, BY THE NORTH SIDE OF LESSER SLAVE LAKE, TO OLD FORT ASSINEBOINE AND EDMONTON.

The report by Mr. McConnell—whose efficient assistance I must not omit to acknowledge—on the country north of Dunvegan to Battle River, has already been given in connection with that part of the Peace River district. His description of the country round the north side of Lesser Slave Lake and thence to Old Fort Assineboine and Edmonton, also of part of the Athabasca, the Rivière and Lac La Biche, and trail thence to Victoria, are here attached, as completing the information on the eastern portion of the area covered by our explorations. Mr. McConnell's notes cover, in addition to the general features of the country, such observations on its geology as he was able to make.—

Report by Mr. McConnell.

Mr. Cambie having passed over that part of the country lying between Peace River and Lesser Slave Lake, and having described it in his report to Mr. Sandford Fleming, it will only be necessary for me in this place to give a very brief description of its general characteristics. Between those two points a very good road has been constructed by the Hudson Bay Company, and passing along this, and forming an opinion of the country merely from that small portion seen from the trail in a thickly wooded region, one might, without hesitation, set down nearly the entire district as eminently adapted for agricultural purposes, as in the whole distance from Peace River to Lesser Slave Lake there is not over five miles, out of a total of sixty-five, of swamp or muskeg; the remainder of the distance being either covered with a growth of aspens, usually of small size, or open prairie land, and the soil being composed of a fine silt, topped with a covering of black mould of variable thickness. Such a conclusion would, however, be very apt to be erroneous, as the country through which a road passes is very far from being a safe guide as to the character of any large section at any distance from it. The roads are usually marked out by Indians intimately acquainted with the country, and are, as a matter of course, carried through the most favourable part of it. In regard to this particular road, Mr. Young, in charge of the Hudson Bay post at the lake, informed me that they had very great difficulty indeed in laying it out on firm ground, and in avoiding the numerous muskegs, and according to him it follows a ridge the greater part of the way,

Road from Peace River to Lesser Slave Lake.

with very swampy land on either side of it. But be that as it may, there must be a large proportion of that country capable of being used for agricultural purposes, as besides the firm land, much of the swampy part could very easily be drained.

The approximate elevation of the watershed between Peace River and Lesser Slave Lake is 2430 feet.

For several miles before reaching the lake, the trail led through a luxuriant growth of wild hay three to four feet high and exceedingly thick. This belt appeared to run round to the south of the lake; on the north, the aspen bush extends right down to the water's edge. Hay swamps.

The first part of Lesser Slave Lake seen, coming from the west, is a large bay about five miles from north to south by three from east to west. This bay receives two rather large streams—Salt Creek, coming from the north, about fifty feet wide by a foot and a half deep, and Heart Creek, coming from the east, and being a little larger. The Hudson Bay Company's post is situated on the eastern side of this bay, facing an island about half a mile in width, which extends right across the bay from east to west, leaving only a narrow channel of about one hundred yards wide between it and the mainland. This island in low water is about two feet only above the surface of the lake, and in high water is completely covered. The bay itself is very shallow, in low water being scarcely over two feet deep anywhere. Proceeding southward, this bay, about four miles from the point where we first reach it, narrows down to about a quarter of a mile in width, and turning directly eastward, continues so for about two miles, when the lake again widens out into another bay about four miles from eats to west and three from north to south. It next narrows again until it is only about a mile wide, and then widens out into the main portion of the lake. Western end of Lesser Slave Lake.

Lesser Slave Lake is about seventy miles long, and lies almost directly east and west. For about thirty miles from the narrows last mentioned, it maintains an average width of from seven to nine miles, then after narrowing again to about three miles in width, it suddenly widens out into a deep bay fully fifteen miles in width, forming the lower end of the lake. Dimensions of lake.

Besides the large bay, just mentioned, at the lower end of the lake, the coast line of which also contains a number of smaller bays, the northern shore of the lake is indented all along its course with shallow bays, varying from one to seven miles from point to point, and very seldom over a mile deep. All along the western and northern sides of these bays, the beach is thickly covered with a mixture of gneissic, sandstone and limestone boulders, while along the eastern side it is a hard sand bank, the sand being probably piled up Shores.

by the prevalent west winds. Along the southern side of the lake, the coast seemed to be pretty regular and to be marshy all the way.

There is only one island in the main lake, and that a very small one, situated at the lower end opposite Lesser Slave River, and distant from it about two and a half miles. Harborage on the lake is also very scarce, there being hardly any place where a boat can obtain shelter, save by running down the entire length of the lake and getting into the river or into the lee of the small island mentioned before. Storms on the lake are also very sudden, the principal ones coming from the west.

Want of harbors.

Hills surrounding the lake.

Lesser Slave Lake receives from the north, besides those already mentioned, four tolerably large streams, from thirty to fifty feet wide, and also a number of smaller ones. Of the two largest of these, one called the Narrows River, falls into the lake opposite the narrows, the other at the large bay at the lower end of the lake. From the south, three or four streams fall into the lake.

Looking from the northern side of the lake, a range of hills appears to run all along its southern shore, but at some distance from it, the land between the hills and the lake being marshy. The furthest of these hills seemed to be from twenty to thirty miles distant, the nearest from ten to fifteen. The principal one is a large flat-topped hill opposite the middle of the lake, but distant from it about twenty-five miles, and probably over one thousand feet high, other hills lying between it and the lake are much lower. Westward they diminish in size till they terminate in a low ridge running round the bay at the upper end of the lake. Along the northern side of the lake, coming from the west, a low ridge about one hundred and fifty feet high follows parallel with it for some distance and then dies away, and the country remains flat till the bay at the lower end of the lake is reached, where a rise in the land of about six hundred feet takes place, forming Raspberry Mountain, which runs round the eastern side of the bay and then stretches eastward. East of the lake, the land is a low marsh, covered with wild hay, along with alder and willow bushes, but separated from the lake by a bank of sand over thirty feet high, probably piled up by ice action.

Trail to White-fish Lake.

While waiting for a guide at the west end of the lake, I rode out about twenty-five miles in the direction of White-fish Lake, in order to obtain some idea of the character of the country bordering the lake on the north. For the first ten miles after leaving the lake, near the mouth of Salt Creek, and proceeding in a north-easterly direction, by compass, the trail leads partly through open prairie and partly through aspen bush. The country is rolling, the hollows usually swampy, and the soil on the higher ground tolerably good, but from the

trail large muskegs, wholly worthless, could be seen on either side. The trail appears to wind along a ridge and so to show more good land than would appear on a line drawn at random.

For the next ten miles the country is much more wooded, the trees consisting principally of aspens, with some spruce, and the proportion of swampy land being very evidently on the increase, until at about twenty miles it culminates in what is known as the Grand Muskeg, a belt of land ten to twelve miles wide and wholly occupied by swamps. Into this we carefully picked our way about four miles and then returned. **Grand Muskeg.**

After passing through the Grand Muskeg, the country improves somewhat, so I was informed, but still remains swampy till White-fish Lake is reached. This sheet of water is about six miles long by three wide, and lies, according to one account, directly north of the west end of Lesser Slave Lake, but according to another statement north-east from that point. Around this lake there is a small area of good land and a little gardening is done. **White-fish Lake.**

Taking this district as a whole, and judging both from what I saw and from what I was told, the country north of Lesser Slave Lake, with the exception of that around the upper end of it, is of very little value, large muskegs and swamps caused principally by beaver-dams and separated from one another by small aspen ridges, occupying nearly the whole of it. Merely to give some idea of its character I may say that the various fur traders took out of that country alone, over twelve thousand beaver skins in 1878. **Country north of Lesser Slave Lake.**

The climate at Lesser Slave Lake appears to compare favourably with that in other parts of the North-west. The snow-fall is not heavy, horses experiencing little difficulty in supporting themselves through the winter. Early frosts appear to give but little trouble here. In Mr. Young's garden the potato tops were quite green when I was there on the 15th of September, although previous to this they had been destroyed at Dunvegan, and when I arrived at Edmonton several days later, I found them cut down there also. Around the bay at the upper end of the lake, there are quite a number of small houses built by half-breeds, with little patches of ground fenced in, but not much gardening is done, as the people depend principally for their food on the wild fowl, which pass over the lake in immense flocks in the fall, and on the white fish with which the lake abounds. **Climate and agriculture.**

From Lesser Slave Lake I had the choice of three routes by which to reach Edmonton, viz.: To go by the old Hudson Bay Company's trail south of the lake, which was reported to be in a comparatively good condition owing to the dryness of the season; to leave the animals at Lesser Slave Lake and go down by water; or, as a third alternative, **Routes to Edmonton.**

Mr. Young pointed out that I might possibly be able, by waiting till the arrival of their boats, which they expected hourly, to get a guide to take me along the north side of the lake, then down to Old Fort Assineboine by a trail which had not been used for some years. As this latter plan held out the inducement of traversing new ground, I determined to adopt it; and on the guide coming in, two or three days later and reporting himself willing to accompany us, we set out at once. Leaving the Hudson Bay Company's post about noon on the 17th of September, on the 19th we arrived at the mouth of Lesser Slave River, travelling on the beach nearly all the way, though sometimes in the bush, and occasionally in the lake itself, the great number of boulders on the beach causing travelling on it to be very slow and toilsome.

Geological features.

The country around Lesser Slave Lake presents very few interesting geological features. Although slides of from ten to thirty feet high occur at intervals along the lake, at no point do they show any rock sections, consisting principally of hardened greyish clays, probably post-tertiary. In some places they are sandy. Stratified rock was observed at one point only, viz., just before entering the deep bay mentioned as existing at the lower end of the lake, where a few small outcrops occur at the water level. These consist of a very argillaceous limestone, which weathers yellow, and is nearly all concreted into round masses cemented together by peroxide of iron. Several of these masses were broken up for the purpose of seeing if they contained fossils, but the search was unsuccessful. The boulders which so thickly strew the beach along its entire course, consist mainly of gneiss and other Laurentian rocks, with, however, a considerable proportion of a whitish, moderately fine-grained sandstone, well rounded; also some angular masses darker in colour and coarser in texture, and a considerable proportion of a light greyish saccharoidal limestone, which, like the sandstone, appeared to be unfossiliferous. A stream about thirty feet wide, which falls into the lake near its lower end, brings down a considerable amount of a very fair kind of lignite, which from its rounded condition appears to have been brought from some distance.

Trail to Fort Assineboine.

Leaving Lesser Slave Lake at its outlet, we set out in a southerly direction for Old Fort Assineboine, on the Athabasca. For a short distance from the lake, the ground is marshy, but gradually became firmer as we advanced, opening out into a beautiful prairie several miles in width, covered with a heavy growth of wild hay and pea-vine. About six miles from the lake, a range of hills, stretching eastward and westward, is reached. At the foot of this we crossed a stream about twenty-five feet wide, apparently descending from the hills, and emptying into Lesser Slave Lake. Ascending this range, it was found to be about eight hundred feet high, the ascent being made in about

three miles. This range of hills is about fifteen miles in width, the southern descent being extremely easy, and being of course less than the northern by the height of the plateau, which is about three hundred and fifty feet above the level of the lake. The summit is a complete network of aspen ridges, running in every direction, and separated by wide muskegs. Eight of these were crossed, the largest being over two miles in width. It was with the greatest difficulty that we succeeded in getting the mules across some of these swamps, even after their loads had been removed and packed across, either on the horses or by ourselves. This part of the country is of the most worthless description, the very small amount of good land being separated by such wide stretches of bad, as to become valueless. Range of hills.

At the highest point of this range that we reached, the barometer read 27·45, while at the level of the lake it read 28·2, thus indicating a difference of 735 feet.

Descending from this point about four hundred feet, we reached and crossed a large spruce swamp, and then passed over another ridge about two hundred feet high, finding at the foot of it a large rapid stream about one hundred feet in width, called by the Indians Tow-i-now-sī-pī. After crossing this stream the country still continued for several miles much broken up by swamps and muskegs, until a low ridge running east and west was reached, which marked the beginning of quite an extensive area of good land, through the centre of which flows a large stream about seventy-five feet wide, called A-kow-i-new-sī-pī. This is joined, about a mile below the point where we crossed it, by a second stream about fifty feet wide, called Wĕ-men-sī-pī-sīs, the united streams continuing to bear the name of the larger one. These streams run each in a beautiful valley about a mile in width, the country for several miles on either side being exceedingly fertile. Near the stream the country is almost entirely open, being merely dotted here and there with clumps of willow, but away from it it becomes densely wooded with a growth of small aspens. Broken country. Prairie region.

Through this aspen bush we travelled for about seven miles, a glimpse from a slight elevation revealing the same general character of country extending indefinitely eastward.

Several barometer readings taken here averaged 28·00, indicating a height of 1880 feet.

About ten miles from the A-kow-i-new-sī-pī the country again changed for the worse, and now became a mere succession of wide muskegs. These seemed to increase in the direction of the Athabasca River, but to diminish somewhat to the west. This style of country continues till the valley of the Clearwater is reached, where we joined the Hudson Bay Company's trail which comes down south of the lake. Bad country bordering the Athabasca.

This we then followed to Old Fort Assineboine and thence to Edmonton.

The Clearwater is a stream fifty feet wide by a foot deep flowing in a very fine valley about two miles wide.

Clearwater to Athabasca.

From the Clearwater to the Athabasca, a distance of about fourteen miles, the country consists entirely of sandy ridges and knolls covered with scrub pine, interspersed with numerous swamps, and without any value whatever. Indeed, from the outlet of Lesser Slave Lake to Old Fort Assineboine on the Athabasca, a distance of about sixty miles, the amount of land passed over fit for agricultural purposes is very inconsiderable, consisting probably of less than one-third of the total area. Between Clearwater and the Athabasca, three small streams were crossed, each from thirty to forty feet wide, and flowing into the Athabasca.

Athabasca Valley.

The Athabasca, where we crossed it, has a valley about four hundred feet deep and about two miles wide, and is itself about two hundred and fifty yards across.

Athabasca to Paddle River.

For several miles after crossing it, the country, though a great improvement on that north of the river, is yet far from good, the soil being a light coloured gravelly silt, with a very thin covering of mould, and broken up by numerous swamps and marshes. About seven miles from the river, however, it improves considerably and becomes fit for settlement, and continues good all the rest of the way in to Edmonton. About twenty-five miles from the Athabasca, Paddle River was crossed, a stream about 100 feet wide by two feet deep, with a bed filled with Laurentian boulders. This stream is a tributary of the Pembina. Between Paddle River and the Athabasca the greater part of the country is very heavily timbered, principally with spruce, aspen and cottonwood, all very large, some of the spruce being over three feet in diameter. The proximity of this timber to the splendid prairie lands around Edmonton must render it in time very valuable. After crossing Paddle River, a ride of eight miles over a beautiful prairie country brings us to the Pembina, a stream about 100 yards wide in low water, with an average depth of about two feet. Its flood banks are about 150 yards apart, and ten to fifteen feet in height, and consist principally of clay The river bed, where we crossed it, is composed of a fine sand. After crossing the Pembina the country is somewhat hilly, but gradually becomes less so till Lac la Nonne is reached, where it is only slightly rolling. The country around this lake is very fertile, though but little farming is done as yet. After leaving Lac la Nonne, the trail for several miles again passes through a thick bush, but the trees are very small and valueless, except for fencing or firewood. Passing through this, we soon cross the watershed between the Athabasca and

Fine timber.

Pembina River.

Lac la Nonne.

Watershed and edge of prairie.

the Saskatchewan, and almost simultaneously reach the southern limit of the true forest and emerge on the open prairie. From this point on to Edmonton, the country is of the most fertile description, being a beautiful, slightly undulating prairie, almost destitute of trees, with numerous small lakelets in the depressions, and watered by several small streams of good water.

Description of the Athabasca from the 'Landing' to Rivière la Biche, and of the country thence to Victoria on the Saskatchewan.

Country near Athabasca Landing. While waiting at Athabasca Landing I made several attempts to explore the country to the east and west of that place, but with very little success. Owing to the character of the country it was utterly impossible to take animals through it, but on foot, I succeeded in penetrating it for a distance of several miles on either side of the trail. As far as I went I found the land to be almost entirely worthless. Where not occupied by muskegs, the soil consists of a light coloured mixture of sand and clay, covered with a thin layer of black mould of a inferior kind; and according to the account of a half-breed trader whom I met at the Landing, this description might apply to the whole country lying between the trail and Rivière and Lac la Biche, excepting only the land in the immediate vicinity of the lake itself. In this opinion, judging from the parts of it which I examined, I fully concur.

Leave the Landing. Leaving the Landing about mid-day on the 15th of October, in a birch bark canoe, with a single half-breed, I came to the mouth of Rivière La Biche about ten o'clock the next morning, having travelled about seven and a half hours. Assuming our rate at five miles an hour, I judged that we had come about thirty-seven miles.

Calling River. Not seeing any appearance of Calling River, which was reported to fall into the Athabasca nearly opposite, I decided to go still further down the river to look for it, but after paddling down about six miles further, we returned, not having seen the river, but having ascertained that it was too far removed from Rivière La Biche to be of service in crossing the Athabasca with a railway line at this point.

Athabasca from Landing to R. la Biche. From the Landing to Rivière La Biche, the river runs in a general north-easterly direction. It is at first somewhat tortuous, with riffles at intervals, but about ten miles from the Landing it widens out considerably, has a gentler current, and shows straight reaches of several miles in length. Approaching Rivière La Biche it again becomes narrow, and bends to the north-west, and still further on nearly west, but where I turned back it was again apparently trending round to the north. The valley presents a nearly uniform character throughout, ranging in width from one to two miles, while the river winding from one side of it to the other, causes the flat which forms the bottom, and which varies

in width from one-eighth to one-half a mile, to alternate from one side of the stream to the other. About ten miles above Rivière La Biche, the slopes of the valley, which before were moderately steep, become much gentler, but further down they again become more abrupt, and narrow in the valley so much that at Rivière La Biche it is not, from one edge of the plateau to the other, over three quarters of a mile.

Plateau decreasing in height.

No rock sections were seen between the Landing and Rivière La Biche, although old slides occur at intervals, and no stream of any size falls into the Athabasca between these two points. A rather singular fact is the decrease in the height of the plateau, this being at the Landing about three hundred and fifty feet about the river, while at Rivière La Biche it is only two hundred.

Find R. la Biche impracticable.

Although we had set out with the intention of ascending Rivière La Biche in the canoe, this was found to be utterly impossible owing to the shallowness of the water, and the strength of the current, poling, paddling or tracking being out of the question in such a stream. The only way in which we made any progress at all was by the half-breed wading in the water and pulling the canoe up after him by the bow, but after nearly a day of this kind of work, finding ourselves less than half a mile from the Athabasca, with the stream apparently getting worse instead of better as we ascended, with three holes broken in the bottom of our canoe, and all our gum expended in the vain attempt to patch them, I decided on abandoning what remained of the canoe, and sent the man on to the Hudson Bay Company's post for a cart.

Road to Lac la Biche.

There is a tolerably good cart road from the mouth of Rivière La Biche to the lake, cut out by a Catholic religious institution at Lac La Biche, for the purpose of getting supplies down to the Athabasca, and thence on to some of their distant missions. Rivière La Biche is the outlet of Lac La Biche, and is about one hundred feet wide at its mouth, but very shallow, not averaging over six to eight inches in depth. It is exceedingly rapid, and its bed is filled with boulders, principally Laurentian, but also with a small proportion of sandstone and limestone. It is very crooked, and although the distance from the lake in a straight line cannot be over fourteen miles, the river must be fully three times that length, making two great bends to the south and one to the north, besides a multitude of smaller ones from one side of its valley to the other.

Valley of R. la Biche.

While the valley of Rivière La Biche is from one quarter to one half a mile wide near its mouth, and two hundred feet deep, after ascending it about fifteen miles it is not over fifty feet deep, showing that the river falls in that distance about 150 feet. From this point on to the lake, it is larger, straighter and has a much gentler current. The cart road follows the river all the way notwithstanding its tortuous course, it being impossible to carry it straight across the

country owing to the numerous muskegs. Leaving the Athabasca, the road passes for about five miles through an aspen bush, where a slight elevation occurring, I endeavored from its summit to obtain a view of Raspberry Mountain, which was reported to be visible from this point, but was unable to distinguish it. Looking towards Athabasca Landing, the country appeared to be almost level, and to present a mere succession of low aspen ridges and muskegs. On descending this elevation a large swamp was found at the foot of it. A narrow strip of good land follows the river, and explains why the road hugs it so closely, but looking away from the river, the country appears to be a mere worthless mass of muskegs, the good land intervening being of too small extent to be of any value. On approaching the lake, which we do through an aspen bush, the land improves very much, and in the last five or six miles is of excellent quality.

Lac La Biche lies nearly magnetic east and west, and is about fifteen miles in length and four to five in breadth. Near its centre, the western coast line, running in a north-easterly direction for about three miles, narrows it down to less than two miles, then turning south-easterly, again increases the width to over five miles. The shores of the lake, wherever I saw them, appeared to be sandy, and to shelve down gradually, although on the opposite side several bluffs from thirty to fifty feet high were seen, which appeared to be of sand. Three streams, each about twenty feet wide, fall into Lac La Biche from the south-west. **Lac la Biche.**

There is a Roman Catholic mission at Lac La Biche, and its effect is found in the number of small wooden houses, and patches of land fenced in, which are seen nearly all round the lake. Although these patches are usually small in themselves, yet in the aggregate they amount to a considerable area. From the stubble I judged that the crops must have been very good, although I could obtain no statistics on this point, owing to the inhabitants being all away engaged in the fisheries. **Agriculture.**

The land around Lac La Biche, although not equal to that in the vicinity of Edmonton, is yet very good. It appears to rise from the lake to a height of about one hundred feet in two or three miles, is rather rough, and, looking up the slope, seems to be dotted here and there with muskegs. The tops of some of the higher rolls were also observed to be gravelly. Still, by far the greater part of the land lying around the lake is fairly good, and will no doubt some day be largely settled. **Soil.**

From Lac La Biche a good cart road leads to Victoria. This first runs in a south-easterly direction to White-fish Lake, distant from Lac La Biche about thirty miles, and passes through open country **Road to Victoria.**

nearly all the way, with the exception of a few miles of aspen bush passed through shortly after leaving the lake. In this section of country, though muskegs occasionally occur, they are not frequent, and will not interfere much with its cultivation, though its hilly nature will lessen its value somewhat for agricultural purposes. A peculiar feature of this country is the number of small lakes which are scattered through it, each being depressed below the plateau level from one hundred to one hundred and fifty feet.

Little and Big Beaver Rivers.

About twenty miles from the lake, Little Beaver River is crossed, a stream about seventy-five feet wide, with a valley about one hundred feet deep. The bed of the stream is full of boulders. About four miles further on we reach Big Beaver River. Judging from the proximity of these two streams, and the direction in which they are flowing, they must unite within three or four miles from the point where the trail crosses them. Big Beaver River is a stream about one hundred feet wide, and very rapid, its bed, like that of Little Beaver River, being filled with boulders. Its valley is about two hundred feet deep and nearly a mile in width. The plateau south of the river is for some distance thickly studded with boulders, rendering it on this account worthless for agricultural purposes. From this point to White-fish Lake, the country is very rough and filled with small lakes. White-fish Lake is about five miles in width by six in length, and is so called from the abundance of white-fish which it, in common with most of the other large lakes in this region contains. The fishing season at White-fish Lake, however, appears to be later than at Lac La Biche, as when I was at the latter place the fishing was at its best, while when I arrived here, two days after, it had not yet commenced. This probably depends on the different temperatures of the two lakes.

White-fish Lake.

Fishing season.

Settlement.

There are forty or fifty families of Indians and half-breeds living about White-fish Lake, most of them doing a little farming. The land, though rough and uneven, is very good, and no difficulty is found in raising cereals and root-crops of various kinds. One field of wheat which I was shown, belonging to Mr. Stainer, the Wesleyan missionary stationed there, averaged twenty-eight bushels to the acre, of excellent grain, although this was the fourteenth consecutive year in which it had been sown with the same crop.

Good Fish Lake.

Good Fish Lake is about three miles from White-fish Lake, but considerably smaller, being about three miles in width by four in length. It is surrounded by a considerable area of excellent land. After leaving it and climbing a ridge about one hundred and fifty feet high, the road passes for several miles through an exceedingly rough country, filled with small lakes, and containing a considerable amount of timber. About ten miles from Good Fish Lake, the water-

shed between Beaver River and the Saskatchewan is crossed, at an elevation of 2150 feet. From this point the road changes its course, running now in a south-westerly direction. The undulations gradually decrease, until about seven miles from the watershed they cease altogether, and the country appears almost perfectly level. During the remainder of the distance to White Mud River, about fifteen miles, the country has the same character, being flat and nearly all open. The soil is somewhat light, with occasional sandy ridges, supporting a growth of black pine. From White Mud River to Victoria, a distance of about eight miles, the road passes nearly all the way through a sandy tract heavily timbered with black pine. Watershed. White Mud River.

Victoria is situated on a large flat about seventy-five feet above the level of the Saskatchewan, and consists of the Hudson Bay Company's post, overlooking the river, and thirty or forty wooden houses, with small farms attached, which run back to the foot of the slope. The flat is about one-third of a mile wide. Excellent crops were reported by the settlers, who are principally English-speaking half-breeds, but I was unable to obtain any reliable statistics. Victoria.

ON THE GEOLOGY OF THE REGION BETWEEN THE 54TH AND 56TH PARALLELS, FROM THE PACIFIC COAST TO EDMONTON.

The geological observations made between the Pacific coast at the mouth of the Skeena, and Edmonton, by way of the Peace River country, may be considered as resolving themselves into the description of a general section. This section is about seven hundred miles in length, and, in the northern part of British Columbia, crosses the whole width of the Cordillera region of the West Coast, embracing on the west the Coast or Cascade Mountains, and on the east the Rocky Mountains proper. General section.

Rocks of the Coast and Skeena River.

It is much to be desired that a systematic examination of the crumpled and highly metamorphosed rocks which compose the Coast Ranges and most of the adjacent islands, should be made, with the purpose of ascertaining the composition of the series, and the possibility, or otherwise, of separating it into subdivisions differing in age. This problem, however, not possessing any apparent immediate economic interest, has been postponed to the definition of the areas of the coal-bearing Cretaceous rocks. The remarks made with regard to these Rocks of the Coast Ranges.

older rocks in previous reports,* therefore still hold, and we must be content to class them for the present under the general name of the Cascade Crystalline series. While the rocks are probably almost exclusively Palæozoic and for the most part of about the Carboniferous period, areas, as yet undefined, of rocks both older and newer, may occur in this disturbed coast belt. In the Report of 1878-79, the older rocks of the Queen Charlotte Islands are described as containing Triassic fossils in their upper portion, but probably passing below into Carboniferous. The series, as a whole, is built up of volcanic products, limestones and argillites, and is not so metamorphic in aspect as that of the Coast Ranges of the mainland. It is highly probable that the felspathic, dioritic and gnessic rocks, with marbles, of the mainland and its fringing archipelago, may represent the lower portion of the Queen Charlotte Island series in a highly crystalline state. At Port Simpson, Work Channel and Metla Katla, a series of schistose rocks appears which may represent the distinctly Triassic argillites of the Queen Charlotte Islands in a metamorphosed condition, but this at present is little more than conjecture. These schists are dark in colour, and may be classed generally as micaceous, though distinct mica crystals are comparatively seldom developed in them. They usually show lustrous satiny surfaces, which are sometimes undulated, and occasionally roughened by the developement between the layers of numerous small garnet crystals. In some layers the dark colour of the schists is evidently due to graphitic material, and calcareous matter is also often present in considerable proportion. Small quartz veins frequently traverse the rocks, particularly in the vicinity of Fort Simpson, where they generally follow the bedding or lamination planes. These rocks appear to compose the greater part of the Tshimpsian Peninsula, dipping at Fort Simpson and Metla Katla, north-eastward, at angles not generally very high, while at the head of Work Inlet, they are found inclined very steeply in the opposite direction. They would thus appear to occupy a synclical among the more massive crystalline rocks. Though the lithological resemblance to the gold-bearing rocks of Cariboo is close, I cannot learn that gold in paying quantity, has been found in connection with the rocks on this part of the coast. The schists from which the well-known large garnet crystals are obtained on the Stickeen River, are doubtless of the same age with these, and similar schists are known to be largely developed on other parts of the coast to the south-east.

Age.

Micaceous schists.

Rocks of Tshimpsian Peninsula.

Garnetiferous schists.

The eastern side of Work Inlet, with the mountains bordering it, appears to be composed of massive granitic or gneissic rocks, the inlet

* Report of Progress Geol. Survey of Canada, 1877-78, p. 169 B.

following the line of junction of these with the schistose series. The little rocky promontory at Port Essington, on the south side of the Skeena estuary, is composed of grey hornblendic granite, traversed by numerous dykes similar in composition but coarser in texture. From this point, for about sixty miles up the Skeena, rocks referable to the Cascade Crystalline series continue to prevail, and though good exposures are seldom met with along the river banks, the rocks are displayed in the bare upper slopes of the mountains. Massive granitic rocks are no doubt largely developed, and form under the influence of the weather, smooth rounded surfaces, which becoming covered with lichen, present from a distance a dull purplish colour. The dips, observed in a few places, were not generally at high angles, and usually in a north-eastward direction. The rocks are gneisses and granites, often hornblendic, with micaceous schists. Fifty miles above Port Essington the last-named rock is shown extensively on small brooks joining the river from the mountains on the left bank.

Granites and Gneisses of Lower Skeena.

Schists.

The supposed general attitude of the rocks on the lower part of the Skeena is shown on the section appended to the map which accompanies this report. The most remarkable point is, perhaps, the absence, in so far as ascertained, of compressed and overturned folds like those of the southern part of the province, represented in the sections published in the Report of Progress for 1877-78.

Porphyritic rocks.

A short distance below the mouth of the Kitsumgalum River, occurs a purplish felspathic rock, which was noted as a porphyrite, but of this, the specimen, with others collected on the Skeena, has not come to hand. Three miles further on, a rock similar in composition, but greenish-grey in colour, again occurs. Both these rocks are in places brecciated, and so massive that the attitudes could not be ascertained. They evidently resemble the rocks named the porphyrite series in previous reports, which are extensively developed on the Iltasyouco and Dean or Salmon Rivers. Rocks of this character, from the colour and appearance of the outcrops, evidently compose the lower hills,—at least along this part of the River,—and it is probable that the low and wide valley of the Kitsumgalum, continued southward by the Lakelse Lake valley to the Kitamat Arm, marks the junction of these Mesozoic rocks with the older series.

Sip-ki-aw granite.

The next exposure seen in ascending the river is at Sĭp-ki-āw Rapid, and is of grey granite of rather coarse texture. It is traversed by jointage planes, which are nearly vertical, and would probably allow the rock to be quarried with some facility in blocks of fair size. They run, on a bearing, S. 22° E. A short distance above the mouth of the Zymoetz River, on the right bank, granitic rocks were again seen, and it is probable that the range running southward be-

tween the Zymoetz and the Sīp-ki-āw is also granitic and that rocks of this kind here form an important mass.

Porphyrites of Zymoetz and Kitsalas.

On the east bank of the Zymoetz, some miles from the Skeena, Mr. H. J. Cambie reports the existence of a massive bed of limestone, dipping about north magnetic, at an angle of 30°. Mr. Cambie also informs me that the stones in the Zymoetz are generally porphyritic, proving the extension of the porphyrite formation in that direction.

About Kitsalas Cañon, the rocks seen in the mountain sides appear to belong entirely to the so-called porphyrite series. In the cañon they are found to be very compact in texture, but much fractured by jointage planes, and otherwise disturbed. They are hard, greenish felspathic materials, occasionally more or less porphyritic in texture, with little epidotic kernels and veins. No bedding could be made out, but they are occasionally traversed by small granitic dykes. About one mile above the cañon, on the right bank, rocks probably of this series, are seen in massive beds in the top of a mountain, dipping about north magnetic at an angle of thirty degrees, For about five miles above the cañon, the rocks, examined in a few places, appear to be chiefly hard greyish argillites and sandstones or quartzites. These are then followed by a second mass of granite of some importance, which has all the appearance of being intrusive and is much jointed.

Material of river gravel.

The material of the bars and banks of the river, and that in the beds of small streams joining it, probably gives a better general representation of the lithological character of the rocks of this part of its course, than the few exposures which occur along the banks. At this point, the gravel consists chiefly of felspathic rocks, purplish, greyish, greenish, or bluish. These are sometimes brecciated, and the breccias occasionally pass into water-formed conglomerates, with well-rounded fragments, the finer materials graduating into ordinary quartzites, sandstones and argillites by intermediate varieties. Fossils were found in some abundance in a bluish felspathic rock, resembling that described in a former report* as carrying fossils on the Iltasyouco. They include *Belemnites*, a *Trigonia*, with other molluscs and a branching coral.

Mesozoic fossils

Sandstones and argillites.

From this point to the Forks, about forty miles following the course of the river, hard sandstones and argillites, often well-bedded, are the prevailing rocks. At Kwatsalix Cañon, these rocks occur in thin regular beds, resembling those of the Nechacco group of the Report of 1876-77. For some miles above Kwatsalix a range of hills follows the right bank of the river, forming in some places a rampart-like escarpment, which is composed of beds of the kind just men-

* Report of Progress Geol. Survey of Canada, 1876-77.

tioned, dipping away from the water. Near Kitseguecla, the rocks change somewhat in character. The sandstones are not highly indurated as before, but rather soft, and associated with carbonaceous shales, which occur at different stages in the formation, and are sometimes ten or more feet in thickness. At a little distance these quite resemble coal seams, and on closer examination are in fact found to include films and small lumps of a material which, though very impure and ashy, may be called true coal. Ironstone in nodules and sheets occurs in abundance in some parts of the formation, and obscure plant impressions were observed in the sandstones. The rocks have been irregularly deposited in many instances, the carbonaceous shales in particular showing a tendency to lenticular forms. The whole series of rocks has since been violently flexed, crushed and disturbed, so much so that even if coal seams of good quality occurred, they would scarcely under any circumstances, be workable in this particular spot. About two miles above Kitseguecla, a well marked anticlinal axis crosses the river, a bed of conglomerate participating in the flexure. At a short distance further up the last rock between Kitseguecla and the Forks is seen. **Impure coal.** **Anticlinal.**

The width of that portion of the belt of Mesozoic rocks crossed between their first appearance on the Skeena and the Forks, is about fifty-seven miles. They lie in a series of folds, of which the axes hold general north-westerly and south-easterly bearings. The angles of dip are often high, and the degree of disturbance implied considerable, the flexures being doubtless very much more numerous and complicated than the diagramatic section would indicate. It will have been observed that while porphyrite, and other felspathic and often brecciated rocks prevail toward the western margin of the region, comparatively soft sandstone, argillites and carbonaceous argillites, characterize the eastern, the intervening region showing rocks more or less intermediate in lithological character and degree of induration. To what extent this change may show a true difference in the character of the formation from west to east, and in how far it may be accounted for on the supposition that older beds, generally characterized by the abundance of volcanic materials, are represented to the west, it is impossible, with the limited knowledge yet obtained of these rocks, definitely to state. It is supposed, however, that the latter circumstance actually occurs, though the first mentioned may also have added to the appearance of difference now found. **General relations of Mesozoic rocks of Skeena.**

Rocks of Babine Portage.

In proceeding eastward from the Forks to the northern end of Babine Lake, across the intervening mountain region, similar rocks

Rocks of Babine Mountains.

continue to prevail. Sandstones are most abundantly represented, but contain in some places carbonaceous shales, and towards the summit of the pass become associated with rocks of volcanic origin like those before described. These occasionally seem to form fully one half the thickness of the beds represented. In one place five miles up the Sus-kwa River, a few impressions of leaves were found. Some of these appear to be coniferous. There is one narrow angiospermous leaf and several grass-like blades. Not far from the summit, numerous fragments of silicified wood were obtained, with a few specimens of a mollusc, which, according to Mr. Whiteaves who has examined the specimens, is a *Thracia* of the section *Corimya.* The species is probably undescribed, but it is identical with one from the coal-bearing rocks of the Queen Charlotte Islands.

Impure coal.

The strike of the rocks throughout this region, is generally nearly true north and south, but subject to great local irregularity. In the bed of the Tzes-a-tza-kwa River, near the point at which the trail from the Forks reaches Babine Lake, fragments resembling coal were found, but contain too much earthy matter to be useful as a fuel. From the appearance of the mountains visible from different points in this region, it seems probable that Mesozoic rocks of the kind described, are very widely spread in this part of the province, a belief confirmed by a number of small specimens collected by Mr. Horetzky to the north, during the expedition of 1879. The hills behind the Hudson Bay post at the north end of Babine Lake, on its west side, are composed of moderately indurated sandstones with fine-grained conglomerates striking N. 43° E., with a north-westerly dip at high angles. The rocks of the Mesozoic series may extend considerably further in this direction, but were not traced.

Mesozoic rocks wide-spread.

The total width of the belt of Cretaceous rocks crossed on this line, which cuts the 55th parallel at a small angle, is little short of one hundred miles.

General Remarks on the Cretaceous Rocks.

Horizon.

Precisely what horizon these rocks represent, it is at present impossible to determine, or as yet to enter into any details as to their arrangement or thickness. From their relation to the Porphyrite series, and the occurrence of the *Thracia* above referred to, it appears, however, that they must represent, at least in part, the coal-bearing series of the Queen Charlotte Islands, while they may even extend upward to include rocks of the horizon of those of Comox and Nanaimo.

Coal-bearing character.

The existence of rocks of this age is not necessarily, in itself, to be regarded as establishing a probability of the occurrence of coal seams of economic value; but the general dissemination over the

district of carbonaceous shales containing impure coal, points to the occurrence of conditions such as those required for the deposition of true coals, and indicates the possibility, if not the probability, of the occurrence of coal beds of a workable character in some part of the region.

Specimens collected by Mr. Horetzky.

Mr. Horetzky collected specimens of the coaly materials found in these rocks on the Skeena, at two localities above the Forks. These were examined by Mr. C. Hoffmann in the laboratory of the Survey, and their analyses published in the preliminary report on this region, which forms Appendix No. 7 of the Canadian Pacific Railway Report of 1879. They have since appeared in Mr. Hoffmann's portion of the Report of the Geological Survey for 1878-79, pp. 12 H. and 13 H., and need not therefore be repeated in this place. The specimens collected by Mr. Horetzky precisely resemble those found at Kitseguecla, below the Forks, but these from the last mentioned place have not been quantitatively examined. They are carbonaceous shales or very impure bituminous coals, containing 1·05 and 1·52 respectively of hygroscopic water and 40·90 and 45·24 of ash. They afford no colour to a boiling solution of caustic potash, and cannot be called lignites.

Coal from Watsonkwa.

In addition to these, I received from Mr. Hankin, when at the Forks of the Skeena, a small specimen of true coal, apparently of excellent quality. This material came from a point on the Watsonkwa River, about eighteen miles from the Forks, and is reported by the Indians to occur in quantity. I was unable to visit the locality, but it lies nearly on the strike of the carbonaceous beds seen near the mouth of the Kitseguecla, on the Skeena, and may therefore occur in a horizon nearly the same. Arrangements were made to procure a larger specimen, but this has not yet arrived.

Analysis.

Mr. Hoffmann has examined a fragment of this coal, with the following result:

Volatile matter	40·52
Fixed carbon	57·51
Ash	1·97
	100·00

A determination of the water gave 0·85 per cent., as however, owing to lack of material, no control was made, the amount of this constituent is included in the figure representing volatile matter. Rapid heating gave a firm coke. The ash, which was somewhat bulky, had a light reddish-brown colour and agglutinated slightly at a bright red heat. This is an excellent fuel and closely resembles a coal of the true coal measures.*

* For details as to physical character of this specimen, see the report above referred to.

In the present isolated position of the northern interior of British Columbia, the possible existence of workable deposits of coal, is a matter of indifference; but in the event of the opening of any route through it, it would be exceedingly desirable to have all parts of the extensive Mesozoic area subjected to a geological examination as close as possible.

Rocks of Babine and Stuart Lakes.

A rapid traverse in canoe and boat of these lakes, did not allow much information as to the rocks surrounding them to be obtained, but it is probable that no very important gap in the section results, as the line nearly follows that of the general strike of the beds. The Cretaceous rocks like those previously described, continue, apparently, for some distance down Babine Lake, but exposures are few. At twenty-five miles from the upper end of the lake, on the west side, a basaltic amygdaloid, evidently of Tertiary volcanic age occurs, and on the opposite side of the lake, near the knee or bend, basaltic rocks form a rather fine display of inclined columns about eighty feet high. At eleven or twelve miles from the upper end of the lake, on the north side, rocks which are doubtless Palæozoic in age, and probably represent a portion of Cache Creek group* appear. They consist of white limestone or marble in thin beds, with greenish schists, hornblendic or occasionally micaceous, and quartzite. These rocks probably also occupy a considerable stretch of the south shore. Eastward they are succeeded by granite, which is in turn followed by basaltic and other Tertiary volcanic rocks, which appear to form a synclinal running north-westward across the extremity of the lake, and compose the conspicuous mountain at its south-eastern angle.

Babine Lake.

Portage.

The trail between Babine and Stuart Lakes, probably leads for some miles over Tertiary volcanic rocks, which are then succeeded by granite, generally grey and hornblendic. The rocks at the Stuart Lake end of the portage are all of this character. The small island at the Yi-ko River is of similar material, with a lamination nearly vertical and running N. 30°W. The mode of occurrence of the granitic and Tertiary volcanic rocks here, resembles that described in a previous report as existing at the east end of Fraser Lake.

Stuart Lake.

In travelling down Stuart Lake, the granites are soon replaced by schistose rocks, which are when first seen greyish in colour, and probably for the most part argillite or quartzite. At a small island on which we landed, about half way down the lake, the rock was found to be a grey glossy schist, probably referable to the Cache Creek group

*See Reports of Progress 1871-72 p. 61, 1877-78 pp. 169 B. 173 B.

of former reports. The massive limestones of the north-east side of the lake were first clearly seen in the range of hills north of the Pin-che River. These limestones have been described by Mr. Selwyn and myself in previous reports, and by the discovery of *Fusulinæ* in them during the exploration of 1876, have been shown to be of Carboniferous age. They are the northward continuation of the typical Cache Creek limestones of the provisional classification of the report for 1871-72. **Carboniferous limestones.**

Stuart Lake to McLeod's Lake.

For the region on the line of trail from Fort St. James, on Stuart Lake, to Fort McLeod, little information exists, for, as elsewhere noted, the drift covering is deep. **Region generally drift-covered.** The nearly parallel section on the Lower Nechacco, about fifty miles further south, is described in the Report of Progress for 1876-77. The Palæozoic rocks of the Cache Creek series are there found to be succeeded to the eastward by a broad belt of Mesozoic and probably Cretaceous rocks, which were designated as the Nechacco series. These are covered to the eastward by accumulations of Tertiary age. The strike of the Cache Creek and Nechacco rocks would carry them across the line of section now described, and the existence of rocks belonging to both these series appears to be proved by the abundant occurrence of fragments referable to both groups in the drift. It is probable that no very extensive spread of Tertiary rocks stretches so far north from the Nechacco, but Tertiary stones are also found in the drift, and about a mile and half east of Carrier Lake, an amygdaloidal basalt with small white crystals of chabazite was seen in place, proving that patches at least of the volcanic portion of the Tertiary occur. A small exposure of hard rusty shales and sandstones of indeterminate character, is seen where the trail first reaches the Salmon River from the west. North-east of Carp Lake, is an isolated exposure of gneissic and granitic rocks, noticed by Mr. Selwyn in 1875.* **Old gneisses and granites.** These rocks are quite peculiar in appearance, being composed of quartz, orthoclase felspar and mica, with garnets, forming in some cases a coarsely crystalline aggregate. As will subsequently appear, they must be older than the rocks of the Misinchinca and Rocky Mountains, and therefore also older than the Cache Creek rocks of Stuart Lake. I believe them to be, in fact, the oldest rocks met with on this line of traverse, and possibly even of Laurentian age. The region here characterized by these rocks is probably not very extensive, judging by their comparatively small representation in the drift of the locality. The occurrence of these oldest rocks forming comparatively low ground

*Report of Progress Geol. Survey of Canada, 1875-76, p 81.

at the present watershed between the Pacific and Arctic streams, which flowing westward and eastward cut through the probably altogether newer ranges of the Coast and Rocky Mountains, is very interesting.

Rocks of Long Lake River.

On Long Lake River and the lower part of Iroquois Creek, somewhat extensive exposures show greenish and grey felspathic schists, occasionally almost nacreous, and associated with grey much hardened but fine-grained limestone and black slaty argillite, which occasionally becomes a micaceous schist. The general strike is N. 77° E., with a southerly dip at an angle of about 60°. These rocks, doubtless form a portion of the Palæozoic series extending eastward from McLeod's Lake.

Rocks of McLeod's Lake, Misinchinca River and the Rocky Mountains.

General arrangement.

About McLeod's Lake, the rocks are limestones and limestone-schists, with felspathic beds, and appear to be sharply folded. From a few exposures noted by Mr. Selwyn, these rocks seem to continue in a northwestward direction on the Parsnip for sixty miles, and it is supposed that they are again represented in the massive and shaly limestones of the main range of the Rocky Mountains, thirty-five miles to the northeast. They appear, in the region between Fort McLeod and the mountains, to form in the main a broad synclinal fold, in which lie the schistose rocks of the Misinchinca River, with a minimum width of fourteen miles. These schists, while showing almost throughout southwesterly dips, are probably arranged in a number of sharply overturned folds, and have no such thickness as would appear on a cursory view. The schists extend northward in this trough for an indeterminate distance, crossing the Peace River at the mouth of the Finlay.

Misinchinca schists.

The section on the Misinchinca, referred to above in general terms, exhibits numerous varieties of schistose rocks, which may be classed together as mica-schists, though differing much in appearance. One of the most abundant is a pale silvery mica-schist, finely laminated and soft. This passes into bluish and grey mica-schists, while felspathic schists and argillites with little micaceous matter are also represented, and in some places hold staurolite. Quartzites are also present, being

Conglomerates.

occasionally, (as in the case of beds which are supposed to immediately overlie the limestones on Atunatche Creek), fine-grained and saccharoidal, but in other places micaceous, and passing into fine grained schistose conglomerates. These are very peculiar in appearance, being composed of rounded or sub-angular fragments of quartz and orthoclase felspar, precisely resembling the varieties of these minerals found in the granitic and gneissic rocks near Carp Lake, the quartz even possessing the same slightly opalescent character. These are imbedded in a silvery micaceous matrix, and the whole has evidently in

some cases been much compressed. It may be that much of the micaceous character of the Misinchinca schists, is due to the inclusion of ready-formed mica from the same source as the quartz and felspar fragments. It is quite evident, that the Carp Lake rocks were fully metamorphosed and undergoing waste, at the time of the deposit of the Misinchinca schists, and as these are clearly the same with those holding gold in the Cariboo region, and probably also with the Anderson River and Boston Bar rocks of the lower Fraser, and schistose zones elsewhere found in the province, an important step in establishing the relative age of some of the older rocks is secured.

Rocks of gold-bearing series.

In some homogeneous beds on the Misinchinca, a superinduced slaty cleavage renders the true dip uncertain. The resemblance of the rocks to those of Cariboo, and the probable identity in age, might lead to the belief that important gold deposits may occur in this wide schistose belt. It is to be remarked, however, that quartz veins are seldom met with, and that the rocks contrast in this respect markedly with those of Cariboo, and though minute scales of gold were obtained in trial washings on the bars in the stream, and the region appears to be one worth prospecting, there is no strong ground for a belief in its richly auriferous character.

Gold prospects.

The north-west and south-east valley occupied by Azouzetta, or Summit Lake, the Atunatche, and the south-east or main branch of the Misinchinca, marks the junction of the schistose rocks with the underlying limestones, which here form the main range of the Rocky Mountains. The higher slopes of these mountains are to a great extent bare, and the dip of the limestone beds can be observed at a great distance. It varies from about 50° to nearly 90° to the south-westward. Behind our camp, at the summit, the general strike was found to be S. 50° E. The thickness of the limestone must be at least 1000 or 2000 feet, and may be much greater. It is generally a bluish-grey crypto-crystalline rock, not highly altered, and lying in rather thin beds, which sometimes become even shaly. Shaly argillites like those of the Misinchinca, but not so much altered, are also seen. Cherty concretions and layers occur in the limestones, resembling the typical cherty quartzites of parts of the Cache Creek group, and some beds of the limestone appear to have been broken up and reconstructed while in process of deposition, forming brecciated layers with evenly bedded ones above and below them. A similar circumstance is noted by Mr. Selwyn with regard to the limestones of McLeod's Lake Mountain, and was also observed in the Stuart Lake limestones. A few very obscure fossils were found in the limestones at the summit of the pass, but not sufficiently perfect for determination. The best preserved is a portion of the dorsal valve of a smooth brachiopod, possibly a small *Athyris* with a strong mesial fold and sinus.

Atunatche Valley.

Massive limestones.

The Omenica Gold District.

The Omenica gold district, lying to the west of the lower part of the Parsnip River, from what can be ascertained of the character of its rocks, must be situated on a trough of schistose sediments similar to that of the Misinchinca, but separated from it by the limestones of the Parsnip and their north-western continuation. As this district has never been visited or reported on by any member of the Geological Survey, though it appears to possess much prospective importance, it may be useful to incorporate what is known of it with the present report.

Routes to Omenica.

The known auriferous localities here lie about fifty miles north of a line passing westward from Pine Pass by Forts McLeod and St. James. There are three routes by which Omenica may be reached.—First, from the coast by the Skeena River, Babine Portage and Firepan Pass. This route is travelled by canoe and on foot. Second, by a trail from Fort St. James, practicable for pack animals; and third, by canoe or boat from the eastward by the Peace and Finlay Rivers. Without entering into details, a glance at the map will show how completely isolated this district is, and account for the scarcity and high price of provisions, which has prevented the working of any but good paying claims and hindered the thorough examination of the country.

Economic importance.

The main points which seem to bear on the possible future of the district are as follows:—(1.) The existence of rich deposit of gold, and the possibility that with greater facility of access the known area covered by these would be increased, and that it would become possible to work those of a lower grade. (2.) The occurrence of pellets of native silver or amalgam in association with the gold. It may not be found possible to trace this material to veins of workable dimensions, but its presence seems in some degree to show the general argentiferous character of the district. (3.) The chief promise of future importance as a mining centre seems to lie, however, in the fact that highly argentiferous galena occurs in some abundance, and, it is reported, in well-defined and wide veins. These it is impossible at present to utilize, owing to the cost of labour and carriage, but the subjoined particulars may serve to give some idea of the character of the deposits.

Argentiferous galenas.

According to Mr. Woodcock, of Victoria, some of the most important veins are in the vicinity of a stream called Boulder Creek.

That known as the "Arctic Circle" is said to be about twenty feet wide, and to show about four feet of highly metalliferous ore. It is exposed by the brook in a face about thirty feet high. The claim adjoining this is called the "Black Warrior," and shows a vein eight feet wide of nearly pure galena. Other specimens have been obtained from places within a radius of eight miles from this locality.

Near Lost Creek a vein known as the "Champion Ledge" is found, and runs nearly parallel with the stream. Particulars as to its size are wanting. Another vein on this creek is reported to be twenty feet wide.

Mr. Woodcock has favoured me with copies of the following analyses of two specimens of the ores from this district, by Messrs. Johnston, Matthy & Co., London, England. **Analyses of galenas.**

Arctic Circle Vein.

Lead	26·80
Iron	2·50
Silver	0.13
Sulphur	6·35
Silica	61·60
Alumina	1·40
Combined water	0·95
Oxygen and loss	0·27

Silver equal to 44·2 oz. per ton of 20 cwt.

A second analysis of the Arctic Circle ore, is by G. W. Hopkins, San Francisco, and gives the following result:—

Silver, per ton, 40·81 oz., or $52.76.

Gold, trace.

Pig lead would contain about 50 oz. to the ton.

Black Warrior Vein.

Lead	20·25
Iron	2·15
Silver	0·09
Sulphur	4·80
Silica	69·80
Alumina	1·50
Combined water	1·00
Oxygen and loss	1·41
	100·00

Silver equal to 29·8 oz. per ton of 20 cwt.

A second assay of the "Black Warrior," by Messrs. Riehn, Hemme & Co., San Francisco, showed the sample to contain 98 oz. or $126.70 of silver to the ton, equal to $187.10 per ton of pig lead.

Two assays of specimens of ore from a deposit known as the "Mammoth Ledge," gave the following results. Assay by Thomas Price, San Francisco:—

Gold, per ton, $\frac{1}{10}$ oz	$ 2.06
Silver, do 32 $\frac{4}{10}$ oz	41.89
	$43.95

Clean galena would assay $131.85.

Assay by Messrs. Riehn, Hemme & Co., San Francisco:—

Gold, per ton	$ 6.28
Silver, do	91.13
	$97.41

Pig lead would contain 207 oz. to the ton.

A specimen of quartz with galena, from a stream near Mansen Creek in the same district, was examined by Mr. Hoffmann some years ago* and found to contain 8·971 oz. of silver to the ton, with traces of gold, but, as Mr. Hoffmann remarks, the silver is confined to the galena, of which a small quantity only occurs in the vein-stone, and which must consequently be highly argentiferous. An analysis in the laboratory of the Survey, of a sample of galena from the Arctic Circle vein, separated as far as possible from the gangue, gave 128 oz. of silver to the ton. A specimen of ore from the Champion Ledge, including galena and gangue, showed 20 oz. of silver to the ton and a trace of gold.

General character of galenas

It would thus appear that a considerable percentage of silver occurs in all the galenas examined from this district, and that if the veins are sufficiently large and constant in character, the region must be of importance when sufficient means of access to it are provided.

All these ores might, by ordinary process of dressing and washing, be raised nearly to the grade which they show when the precious metals are calculated to the proportion of galena contained.

Miners.

During the summer of 1879, there were, as I have been informed, about sixty white men engaged in Omenica, with twenty Chinamen, and sixty to seventy Indians, the latter receiving wages as labourers at $3 a day. I am inclined to believe, however, that these figures may be rather above the mark than below it.

Rocks of Upper Pine River.

Fossiliferous limestones.

In travelling down the Pine River from its source, the attitude of the limestone beds is found to become less uniform, and they appear to be nearly flat in some of the mountains. The pebbles in the stream are almost entirely of glossy schists like those of the Misinchinca region, though these rocks were not observed in place in this part of the valley. Near the northernmost point of the bend which Pine River now makes, on the left bank of the stream, some fossils were found, in beds of shaly limestone with south-eastward dip at an angle of 80°. The fossils have been examined Mr. J. F. Whiteaves, who recognizes

* Reports of Progress Geol. Survey of Canada, 1875-76, p. 430, 1876-77, p. 116.

* Report of Progress Geol. Survey of Canada, 1878-79, p. 24, H.

among them *Atrypa reticularis*, Linn. and another species of brachiopod too imperfect for determination. Also three or four species of corals, mostly fragmentary, one of them apparently a *Zaphrentis* or *Cyathophyllum*. A mile and a quarter further down, a stream enters from the north, constituting the Upper Fork of the river. To the west of this stream is a block of mountains, high and rough, the beds of which appear to have general south-westerly dips, and are for the most part limestones. Along the north-eastern escarpment of this range, however, extensive beds of saccharoidal quartzite must appear, probably coming from below the limestone, as the brook just mentioned is paved with quartzite and limestone pebbles almost to the exclusion of the silvery schistose fragments, which to this point characterize the bed of the main stream of Pine River. Quartzite.

A few miles further on, near the eastern base of Canoe Mountain, in rock slides which descend from it to the border of the river, were found, the cast of a small *Rensseleria*, which, according to Mr. Whiteaves, is rather like *R. lævis* of Meek from the Devonian rocks of the Mackenzie River, with some unrecognizable fragments of other brachiopods.

Toward the eastern border of the limestone ranges, the beds become much disturbed, and hard black calcareous shales holding numerous specimens of *Monotis subcircularis*, like those described by Mr. Selwyn on the Peace River forty miles to the north-westward, appear. The precise relation of these rocks to the limestones was not ascertained, and I regret that the time at my disposal did not allow a more complete examination of the rocks in the vicinity of Canoe Mountain. It remains uncertain whether the limestones form an anticlinal overturned to the eastward, or meet those newer beds at a line of fault. No indications of the latter structure were, however, noticed. It may not improbably be that the *Monotis* beds are the little altered representatives of the schists of the Misinchinca River. Immediately after the appearance of the *Monotis* beds, at the point where the Pine River assumes a north-easterly course, the older rocks are concealed by the outcrop of the Cretaceous sandstones and conglomerates. 'Alpine Trias.'

Cretaceous Rocks of Pine River

At whatever period the elevation of the Rocky Mountain range to the south and east of this point may have occurred, it is clear that portions of the limestones and associated rocks above described, must have projected as islands, or formed a more or less continuous shore-line at the time of the deposition of the Cretaceous beds here lying to the east of them. These, in the vicinity of the mountains appear to be composed almost exclusively of sandstones and conglomerates, and with Rocky Mountains a shore line.

little exception maintain this character on the Pine River as far as the Middle Forks, a distance in a direction at right angles to the main axis of folding, of thirty-four miles from the older rocks. The sandstones are generally brownish in colour, contain little calcareous matter, and are often quite coarse in grain. They are usually regularly bedded, and broad surfaces are frequently ripple-marked. In the coarser grits and conglomerates, the constituent fragments are found to be almost entirely of cherty material like that occuring in the more resistant of the limestone beds about the summit of the pass. In the immediate vicinity of the mountains, these rocks are thrown into a series of sharp folds, which have a general direction of north-west by south-east, and in which the beds occasionally even show overturned dips. At about sixteen miles from the edge of the older limestones, the flexures of these rocks, which have been diminishing in amount, cease, and the beds become practically horizontal; and though at the Middle Forks slight undulations were again noted, these are probably not more than may be accounted for by some original inequality in deposition. From sections exposed in the nearly bare hillsides of Pine River, the thickness of the series must be at least 2000 feet, and may be much more.

Sandstones and conglomerates.

Flexures.

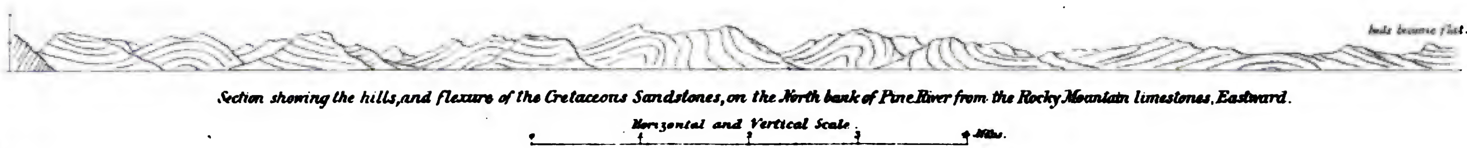
The flexures of the sandstone series, as they occur in the hills forming the north side of the Pine River valley, are shown in the section on Plate 7.

Increase of shales eastward.

While there is no means of arriving at the precise age of most parts of the sandstone series of the Upper Pine River, I see no reason to doubt that it forms the coarse littoral portion of the Cretaceous rocks which spread so widely to the eastward. It seems probable, as more fully detailed elsewhere, that fine shaly materials become increasingly abundant in receding from the mountains, and that the rocks eventually resolve themselves into the subdivisions described below. Further, while the rocks of the Upper Pine River may be described as sandstones and conglomerates, shaly beds are not altogether absent. At a point nine miles from the western edge of the formation, two beds of carbonaceous shale, four and three feet thick respectively, were observed to occur near the water level. They include coaly fragments, and obscure impressions of sedge-like plants were found in sandstones in the same vicinity. At another place, nineteen miles from the western edge of the limestones, about fifty feet in thickness of blackish shaly beds appears in a lateral ravine. With the shales are beds of nodular ironstone, and thin ferruginous sandstone layers. These beds underlie the mass of the sandstones forming the hills, and probably represent the summit of the 'Lower Shales' of the classification subsequently given, for in the sandstones several hundred feet above

Babine Range, Ne-tal-tyul Mountains from the North East.

Babine Range. Looking North from Skeena Forks.



Section showing the hills, and flexure of the Cretaceous Sandstones, on the North bank of Pine River from the Rocky Mountain limestones, Eastward.

them, Mr. McConnell found a few fossils which appear to be identical with those characterizing the 'Lower Sandstones' of the Lower Forks of Pine River. On these specimens Mr. J. F. Whiteaves furnishes the following note:—

Cretaceous fossils.

1. *Cyrena*—Casts of a *Cyrena*, with outline very like that of *C.* (*Veloritina*) *Durkeei* of Meek, from the "Bear River Series" of Wyoming and Utah.

2. *Corbula*—Cast of the left valve of a large *Corbula*, apparently closely allied to the smooth variety of *C. pyriformis*, Meek, from the Bear River Series of Sulphur Creek, near Bear River, Utah, but broader posteriorly and with the beaks pointing distinctly forwards. The same species was collected by Mr. Selwyn at Pine River Forks, in 1875. In the same year Mr. Selwyn collected at Dunvegan, and on the Peace River, 36 miles from Dunvegan, specimens of a *Neæra*-like *Corbula*, which can scarcely be distinguished from the ribbed variety of *C. pyriformis*, but in those shells the posterior end is elongated and narrowly attenuated and the beaks point decidedly backwards.

3. *Pteria*—Cast of the left valve of a small *Pteria*. Much too imperfect for identification, but apparently rather like *P. Nebrascana* of Evans and Shumard.

4. *Ostrea*—Detached valves of a small species.

At a point somewhat further up the river, impressions of a large *Inoceramus* were observed, but it was found impossible to procure specimens.

Subdivision of the Cretaceous.

These rocks of Upper Pine River appear to me to represent those described by Mr. Selwyn on the corresponding portion of the Peace River above the Cañon of the Mountain of Rocks. From a study of Mr. Selwyn's section on the Peace River, in conjunction with the additional information now obtained, and more particularly in the light of the fine sections on the Smoky River, I believe that the rocks underlying the portion of the Peace River country embraced in the present report may be subdivided as follows, in descending order:—

1. Upper sandstones and shales with lignite coals. (Wapiti River Sandstones.)
2. Upper dark shales. (Smoky River Shales.)
3. Lower sandstones and shales with lignite and true coals. (Dunvegan Sandstones.)
4. Lower dark shales. (Fort St. John Shales.)

For the region lying to the east of the point now attained in the course of the description, it will be more convenient to treat of the places characterized by each subdivision together.

Lower Shales.

Lower Shales.—This subdivision, according to Mr. Selwyn's notes, appears to occupy the Upper Peace valley for a length of nearly fifty miles, extending from a point about six miles below Hudson's Hope to a short distance below the mouth of Pine River North. The rocks are described* as "dark earthy shales, in parts characterized by numerous bands and septarian nodules of clay ironstone, many of which enclose large ammonites, and they are also associated with sandy calcareous layers holding other Cretaceous fossils, among which a species of *Inoceramus* is tolerably abundant, while in the dark argillaceous shales scales of fishes are frequently observed." In a section about a mile below Fort St. John, these rocks have a thickness exceeding 600 feet. The area occupied by the lower shales is not wide, however, as the overlying sandstones are found in the higher ground at no great distance back from the river valley. At the point above mentioned, in descending the Peace River, they are overlain by the sandstones of the next succeeding subdivision, and do not again appear till at about five miles below the mouth of the Rivière Brulé, or twenty-five miles above the confluence of the Peace and Smoky Rivers. They extend for about the same distance up the Smoky River, till the light southerly dip of the beds brings the overlying subdivision down to the water level. On Peace River, below the mouth of the Smoky, these beds are followed by sandstones which at some distance down the stream form rampart-like cliffs. These have not, however, been geologically examined, and it is not known whether they are a return of the Lower Sandstones, or a yet older series underlying the Lower Shales.

Exposures on the Peace River.

The small exposure of shales probably representing this subdivision on the Upper Pine River, has already been alluded to.

Fossils.

The fossils obtained by Mr. Selwyn from those rocks near Fort St. John, include numerous crushed specimens of a large *Ammonite*, resembling, according to Mr. Whiteaves, *Prionocyclus Woolgari*, but a new species. The *Inoceramus* may not improbably be *I. problematicus*, and a *Pteria* specifically the same with one from the locality on Upper Pine River described on p. 115 B.

Lower Sandstones.

The Lower Sandstones and Shales, constituting the next subdivision, appear to be much more widely spread. It is probable that a considerable part of the sandstones of the Upper Pine River may belong to this subdivision. It is well characterized, however, about the cañon and at the Lower Forks of Pine River, and seems from the information at present available, to occupy the valley of Peace River for a distance of about one hundred miles, between the mouth of Pine River North, and the point below the mouth of the Rivière Brulé indicated in

* Report of Progress Geol. Survey of Canada, 1875-76, p. 72.

a preceding paragraph. It also crosses the Smoky River with a width in the bottom of the valley of nine miles, and may further, I believe, be regarded as probably including the sandstones of the Cañon of the Mountain of Rocks above Hudson's Hope.

In the Pine River Cañon, the rocks of this subdivision are flaggy sandstones, often brownish-grey in color and false-bedded or ripple-marked, greenish-grey fine-grained sandstones and black soft argillaceous sandstones and shales holding plant impressions, also occur. In the valley of a small stream which cuts the bank on the south side of the cañon, not far above the river level, Mr. Selwyn, in 1875, found, in alternating strata of sandstones and shales, four thin seams of coal, which in descending order are—six inches, eight inches, two feet, and eight inches thick. A number of fossils were also found in the associated beds, consisting of leaf-impressions and shells. "The former occur chiefly in beds below the coal seams, and the latter in the intervening sandy shales, and in the ferruginous and calcareous concretionary nodules which accompany the latter." These coal seams and the associated beds are at least 1700 feet below the sandstones of the summit of Table Mountain, and as the beds are nearly horizontal, this difference in elevation must closely correspond with the actual thickness of the rocks. For a portion of the ascent of Table Mountain, however, the rocks are not seen, though about 200 feet thick of sandstone caps the hill. It is therefore uncertain whether the subdivision classed as the Upper Shales may occur in the concealed interval and the sandstones at the summit represent the Upper Sandstone series, or whether,—as is perhaps more probable,—the entire thickness of the rocks from the edge of Pine River to the summit of Table Mountain, should be classed as belonging to the Lower Sandstones, which in this case must here have a very great thickness. In the sandstones of the summit of the mountain numerous specimens of *Inoceramus altus*, a species previously noted in beds supposed to represent the Pierre group in Wyoming, were found by Mr. Selwyn. The fuel occuring in the above-described section scarcely differs from true bituminous coal, containing, according to an analysis by Mr. Hoffmann but 2·45 per cent. of water, and yielding a hard coke.

Exposures in Pine River Canon.

Coal seams.

TableMountain

The fossil plants and molluscs, obtained from the beds in the vicinity of the Lower Forks of Pine River, are reviewed on a succeeding page.

On the lower part of Coal Brook, which flows into the East Branch of Pine River, extensive exposures of the Lower Sandstones occur. Coal was discovered here by Mr. J. Hunter in 1877, and is mentioned by him in the Canadian Pacific Railway Report of 1878 (p. 79). Mr. Hunter favoured me with specimens collected by him at the time, and I have since personally examined the locality. The coal occurs in several

Coal Brook.

beds and appears to be of good quality, but so far as observed all are very thin, the thickest measuring about six inches. The coal resembles that above mentioned, but contains 7·83 of water and less ash, and does not yield a coherent coke. Coal also occurs on the east branch of Pine River above the mouth of Coal Creek, and there is much ground to hope for the discovery of coal seams of workable thickness in this region.

Coal seams.

The rocks associated with the coals are sandstones and sandy shales, generally grey, but becoming blackish where most argillaceous. The series is usually very regularly bedded, though many of the sandstones show current structure, and there are occasional marked local departures from horizontality. The beds also include ironstone, which in some places is quite abundant, forming nodular sheets. Ironstone also occurs in this manner in some of the rocks of the same subdivision seen about the Forks of Pine River.

Ironstone.

Exposures on Peace River.

On Peace River, the rocks of this subdivision are supposed, as above noted, to form the banks for a long distance. They are described as consisting of similar alternating sandstones and shales, the former often worn out by the weather into fantastic shapes, the latter generally markedly arenaceous in character. In the bare hill behind Dunvegan, a thickness of about 400 feet of these beds is shown, consisting of brown and grey sandstones and sandy shales, which hold numerous fossils. The beds appear to be horizontal or nearly so throughout.

On the Rivière Brulé, near its mouth, about fourteen miles from Dunvegan, Mr. McConnell examined a reported coal seam, which proved to be a lignite coal of inferior quality, and about twelve inches only in thickness. Coal or lignite is also reported to occur on Rat River ten or fifteen miles from Dunvegan, but the locality was not visited. Thin irregular seams of poor lignite were noticed in banks a few miles below Dunvegan on the same side of the river.

Exposures on Smoky River.

On Smoky River the Lower Shales appear to blend at their summit with the subdivision now under consideration, which is shaly at the base, but in the main represented by sandstones, generally yellowish and soft, but often nodularly hardened. The nodules or concretions are frequently masses exceeding six feet in diameter, which as they weather from the bed fall into the river, and considerably impede its course. The highest bed of the Lower Sandstones is found at a sharp bend of the river, with a rapid, three miles north of the Little Smoky. It is a massive soft grey sandstone, with abundant fragments of plants, often root-like, and in one place distinctly representing the base and roots of a tree, and evidencing a terrestrial surface. Overlying this is a thin carbonaceous film, which at a short distance further up the river becomes a seam of lignite coal two and a half inches in thickness.

This, according to an analysis by Mr. Hoffmann, contains 11·52 per cent. of water. It is interesting to find the coal-bearing character of this part of the formation maintained, though by a seam so inconsiderable, so far to the eastward.

The beds seen in the Cañon of the Mountain of Rocks, are sandstones, conglomerates and shales with coal seams. The thickest seam observed by Mr. Selwyn in this place was but six inches,* but in July, 1879, Mr. Cambie noticed one about two feet in thickness. The following analysis of a specimen of coal from this locality, collected by Mr. Selwyn, is published by Dr. Harrington.† Coal from Rocky Mountain Canon.

	Slow coking.	Fast coking.
Water	2·10	2·10
Volatile combustible matter	21·54	25·09
Fixed carbon	71·63	68·08
Ash	4·73	4·73
	100·00	100·00

Ratio of volatile to fixed combustible by slow coking 1–3.32, by fast coking 1–2·71. By rapid heating the coal yielded a fine coke, and it may be regarded in all respects as a fuel of excellent quality, only requiring to be found in sufficient quantity to claim importance.

The resemblance between this and the coal from Pine River Cañon is close, and both are better in quality than those from any other part of the region east of the mountains embraced in this report.

From the rocks which I have called the Lower Sandstones, in the vicinity of the Lower Forks of Pine River, a number of molluscan fossils have been obtained. Some were collected by Mr. Selwyn in the beds associated with the coals on Coal Gully near the cañon. Others by myself in large loose blocks in the lower part of the East Branch. Among those collected by Mr. Selwyn the following forms occur, according to Mr. Whiteaves:—

A fragment of an *Inoceramus*, valves of *Pteria*, *Cyrena*, *Ostrea* and a broken cast of a *Unio*. Of these the second and third are specifically identical with those represented on the Upper Pine River, described on p. 115 B. In addition to these a *Corbula*, the same with that from the place just referred to, and a smooth *Goniobasis* were found by us. In 1875, Mr. Selwyn procured the following fossils at Dunvegan, behind the Fort:—*Ostrea* sp., *Inoceramus*, *Corbula* like *C. pyriformis* Meek, *Brachydontes multilinigera*, Meek, *Corbula*, small species, *Cyrena*, *Goniobasis*, and a small belemnite. A specimen of *Scaphites ventricosus* was Fossils from Lower Sandstones.

* Report of Progress Geol. Survey of Canada, 1875-76, p. 63.

† Report of Progress Geol. Survey of Canada, 1876-77, table facing p. 470.

also found loose in Muddy Creek near Dunvegan, and at a point thirty-six miles above Dunvegan, on the Pine River, an assemblage of forms like those of Dunvegan is again found, but with the addition of a shell like a *Mactra* or *Tellina*. No molluscan fossils or determinable remains of plants were found in the Lower Sandstones on the Smoky River.

Fossils from R. Brulé.

The fossils before alluded to, obtained in loose stones in the Rivière Brulé, or Burnt River, by Mr. McConnell, though very like some Laramie forms, may be of the same age as those above described. They include, according to Mr. Whiteaves, the following forms: *Unio* nov. sp?. *Corbula pyriformis?* Meek, *Corbula Engelmanni?* Meek, a *Vivipara*, like V. *Conradi*, M. & H., a *Lioplax* (or *Cassiopella*) like L. *subtortuosa*, M. & H., sp., a species of *Goniobasis*, very like the smooth-shelled variety of *G. Simpsoni* Meek.

The plant remains from the lower shales are from the Pine River Cañon, the Forks of Pine River, and lower part of Coal Brook, places included in a district not over eight miles in diameter, and may be treated together, though the separate localities are indicated in connection with the species mentioned. The following preliminary note on these plants has been kindly furnished by Principal J. W. Dawson:—

Note on Cretaceous Fossil Plants from the Peace River Country.

Note on fossil plants by J. W. Dawson.

The plants referred to below are of much interest, as representing in a northern locality a flora akin to that of the Dakota Group of the United States geologists, which may be regarded as Lower Cretaceous or at least as belonging to the lower part of the Middle Cretaceous, and is the oldest in which broad-leaved Exogens of similar types to those now existing predominate. It will, however, be seen, from the table (p. 128) that these plants occur in beds believed to be somewhat higher in the series, or nearly on the horizon of the Niobrara group. They will thus supply an interesting link in the history of the American Cretaceous.

The present note is intended merely as a preliminary to a more full description.

1. *Cycadites.*—The collection contains several leaves of this genus, all belonging to one species, and of the type of the modern *Cycas revoluta*, though of small size, the largest having been less than a foot in length. This species is closely allied to leaves of this genus found in the Cretaceous of Europe, but is probably new; and will be described under the name of C. *Unjiga*, from the Indian name of the Peace River. The specimens of this species are chiefly from Pine River Forks. One fragment occurs in the collection from Table Mountain, apparently

from the reddish sandstones near the top, which contain *Inoceramus altus*, and a well preserved leaf was obtained by Mr. Selwyn from a loose slab on that part of the Peace River occupied by the Lower Sandstones twenty-five miles above Dunvegan.

2. *Carpolithes.*—One specimen represents a remarkable fruit which is either a nut of three centimeters in diameter, surrounded with a dense mass of radiating laminar fibres, five centimetres long, or is a rounded rhachis bearing very long fruit scales. The central mass is carbonaceous, and shining, with spiral pits marking the attachment of these surrounding organs. These are apparently flat, three millimetres wide, with a central smooth band, and scolloped or toothed edges. I can only conjecture that it may be a peculiar globular mass of fructification, possibly of some cycadaceous plant, but of course not probably belonging to that which bore the leaves above mentioned. From the Forks of Pine River.

3. *Magnolia.*—Of this genus there are two well-marked kinds of leaves. One of them is closely allied to *M. tenuifolia* of Lesquereux, but more acute at the point. The other is a larger leaf, seventeen centimetres in length and six broad, and remarkable for narrowing in a uniform manner from the middle to the base and apex. Both species are from Coal Brook.

4. *Carya.*—Leaflets of apparently a very large hickory leaf, with the nervation of this genus, but with entire edges. These specimens are from Coal Brook.

5. *Protophyllum.*—Of this genus, quite characteristic of the Dakota Cretaceous, but of somewhat uncertain affinities, there are two species, one of them allied to *P. rugosum* of Lesquereux, the other quite distinct, but resembling an unnamed species from the Dakota group of Ellsworth, Colorado, now in the collection of the McGill University. The specimens of both these species are from Coal Brook, where they are to be found scattered over large slabs in a fine state of preservation, but difficult to break out without proper tools.

6. *Menispermites?*—A very broad leaf, ten centimetres wide and seven long, cordate at base and with waved margins and seven nerves. Coal Brook.

7. *Salix.*—A long narrow-leaved species, like *S. flexuosa*, Newberry, or *S. protæfolia*, Lesq. Coal Brook.

8. *Laurophyllum.*—Resembles Lesquereux's *L. reticulatum*, a very characteristic Dakota species. Pine River Forks.

9. *Diospyros.*—Group of leaves, scarcely, if at all, distinguishable from *D. anceps*, Lesq. Pine River Forks and Cañon.

10. *Glyptostrobus gracillimus*, Lesq.—This very characteristic plant, whatever its true affinities, is represented by a number of branchlets,

most of them obscure, but some quite distinct. Specimens from the Forks of Pine River.

11. *Sequoia*.—A few branchlets of the type of *S. Langsdorffii*. From the Forks of Pine River.

12. *Sphenopteris*.—A delicate fern, referable to this genus provisionally, till its fructification can be found. From the Forks of Pine River.

The above accord with the stratigraphical position assigned to the beds, namely below the horizon of the Fort Pierre Cretaceous. It is a distinct flora from that of the Cretaceous coal-measures of Vancouver Island, or that of the Laramie or Lignite Tertiary of the plains. It is older than either, and very nearly akin to that of the Dakota group, as illustrated in Lesquereux's Memoir in the Reports of the United States Geological Survey of the Territories, and Newberry's "Illustrations" in the same reports.

The presence of remains of a *Cycadites* is a noteworthy feature, especially when we consider the northern latitude of the locality, and serves as a link of connection with the Lower Cretaceous and Jurassic floras. These Cycadaceous remains are, however, quite distinct from those from the Lower Cretaceous of the Queen Charlotte Islands, collected by Mr. Richardson and described by me in the Report of the Geological Survey of Canada for 1873.

Estuarine and fresh-water molluscs.

The Lower Sandstones evidence estuarine, fresh-water and terrestrial conditions throughout, and the molluscs show a mingling of distinctively Cretaceous forms, with fresh-water types, the closest analogy of which is with those of the Laramie Group. Though some doubt may obtain as to the stratigraphical position of the fossils found loose in Rivière Brulé, which may possibly represent an outlier of Laramie, this need not be allowed to influence our conclusions with regard to the others. The molluscs and plants of Pine River Cañon lie together beneath at least 1700 feet of strata, the uppermost beds of which hold *Inoceramus altus*; and judging from the general persistency in type of land and fresh-water molluscs it will be by no means surprising if, when more points of comparison are available, the earlier Cretaceous and Laramie faunas are proved to resemble each other very closely.

Upper Shales on Coal Brook.

The Upper Shales, constituting the next overlying subdivision, were well seen only on Coal Brook and on the Smoky River. On the first-named stream, five miles east of the Lower Forks of Pine River, the Lower Sandstones are succeeded by dark grey or bluish-black thin bedded shales, of which at least 200 feet in thickness is exposed in ascending the brook to the point at which the valley becomes shallow and drift deposits conceal the underlying rocks. At their base the Upper Shales blend to some extent with the underlying sandstone forma-

tion, and near the line of junction were found a few marine shells, among which is a small *Ostrea*.

The Upper Shales cross the Smoky River with a width of about thirty-six miles. The rocks are here greyish and bluish to nearly black shales, and hold abundance of ironstone, and in some places large ferro-calcareous septarian nodules. In one locality a layer of nearly pure ironstone three to four feet thick was noticed, which further down the river became a ferruginous sandstone, but maintained its place and thickness with great regularity for miles, and enabled the fact of the low southward dip of the rocks to be ascertained, by rising in the bank faster than the bed of the river could be supposed to slope down. **On Smoky River.**

A specimen of ironstone from this part of the Smoky River has been found by Mr. Hoffmann to contain 30·98 per cent. of metallic iron, with 15·94 of insoluble matter. **Ironstone.**

Near the base of the subdivision occurs a considerable thickness of very dark shales, probably highly carbonaceous. In these the slow and smothered combustion which has given the Smoky River its name, has taken place in a number of localities, and was in progress in 1879 in a scarped bank forming the angle at the junction of the main stream with the Little Smoky. The very lowest beds of the subdivion become paler in tint near the junction with the Lower Sandstones. **Bocannes.**

The combustion of the shales on Smoky River was observed in August, 1879, in but one locality, that just alluded to. A small quantity of smoke was here seen issuing from crevices at a considerable height above the river, while reddened masses of shales indicated portions of the beds which had already been burnt out. These so-called 'Bocannes' are described by Mr. Selwyn in the report already several times referred to,* but those seen by him were nearer the mouth of Smoky River, and in the Lower Shales of my classification. At the time of my visit to Smoky River no combustion was observed in the Lower Shales, though marks of its former occurrence were seen. An examination of specimens of the shale by Mr. Hoffmann shows the presence of a large quantity of very finely divided pyrites, with carbonaceous matter. These together are quite sufficient to account for the slow combustion observed, and the pyrites may under certain circumstances spontaneously initiate the phenomenon by the heat evolved during its decomposition. **Cause of the combustion.**

From the upper portion of the Upper Shales on the Smoky River, a short distance north of the crossing place of the trail from Dunvegan to Sturgeon Lake, in latitude 55° 28′, a number of fossils were obtained, **Fossils from the Upper Shales.**

* Report of Progress Geol. Survey of Canada, 1875-76, pp. 58, 73.

among which Mr. Whiteaves recognises the following forms, proving the horizon to be that of the Pierre Group of the Missouri region, with the addition of a few forms of the Fox Hill, or next overlying group, and establishing a close connection between those remote localities:—

Hemiaster Humphreysianus, Meek & Hayden.
Ostrœa.
Pteria linguiformis, Evans & Shumard.
Pteria Nebrascana, Evans & Shumard.
Inoceramus mytilopsis, Conrad. Abundant.
Volsella,—like *V. Meeki* of Evans & Shumard.
Limopsis parvula? Meek & Hayden.
Nucula cancellata, Meek & Hayden.
Nuculana bisulcata, Meek & Hayden.
Protocardia (Leptocardia) rara, Evans & Shumard.
Goniomya Americana, Meek & Hayden.
Liopistha (Cymella) undata, Meek & Hayden.
Anisomyon patelliformis? Meek & Hayden.
Lunatia, species indeterminable.
Aporrhais biangulata, Meek & Hayden.
Scaphites ventricosus, Meek & Hayden.
Baculites, crushed fragments. Species unrecognizable.

Upper Sandstones and Shales.

The Upper Sandstones and Shales are well shown at the mouth of Mountain Creek, which enters the Wapiti or Elk River thirteen miles from its mouth, and on the lower part of the Wapiti River. About the mouth of Mountain Creek are numerous exposures of horizontal beds consisting of sandstones, generally soft and flaggy, shaly sandstones, shales and clays. The sandstones are often nodular, and hold bands and sheets of ironstone, together with coaly fragments and obscure fossil plants. They are yellowish, or greyish, or bluish-grey in tint, while the shales and clays have often a brownish earthy appearance. This earthy character of parts of the formation, at times renders it difficult to distinguish it locally from the overlying drift deposits; but it would appear that at least one bed of soft rusty conglomerate is included in it. The pebbles in this are composed chiefly of Rocky Mountain quartzites, while those now found in the bed of the river show a considerable proportion of Laurentian origin. Owing to its horizontal or nearly horizontal attitude the total thickness of beds exposed, belonging to this subdivision, is not great, probably not more than 200 to 300 feet.

Lithological character.

Lignite coal.

In Mountain Creek, large fragments of lignite coal in angular blocks which have evidently not travelled far, strew the bars. Very thin seams of coal were observed in the banks, but the loose pieces must be derived from thicker beds, which may outcrop below the water of the brook or be concealed by slides in the banks. Similar fragments of lignite coal

are found along the Wapiti River above the mouth of Mountain Creek, showing that coal beds must also occur on the upper course of the Wapiti.

The lowest beds of this subdivision occur on Smoky River, at the water level, about ten and a half miles below its junction with the Wapiti, but it is seen in the higher parts of the banks for about eleven and a half miles further down, or to the crossing of the trail from Dunvegan to Sturgeon Lake. Near the base, a seam of good lignite coal five inches in thicknes was observed, associated with the following strata, in descending order to the water level:— Section at base on Smoky River.

	Feet.	Inches.
Shaly clay	6	
Sandstones with ironstone nodules	5	
Shales	7	
Sandstone	10	
Coal	0	5
Carbonaceous shale forming an underclay	2	
	30	5

Thickness of Subdivisions on the Smoky River.

The average southerly dip of the beds exposed in the Smoky River section appears to be at the rate of five to eight feet in the mile. Taking this in conjunction with the probable slope of the river bed, the following approximate minimum thickness for the several subdivisions as here developed, is obtained:—

	Feet.
1. Upper Sandstones and Shales, top not seen	200
2. Upper Shales	350
3. Lower Sandstones and Shales	100
2. Lower Shales, base not seen	250
	900

No fossils were obtained in the Upper Sandstones and Shales, nor, in the Smoky River section, in the Lower Sandstones and Shales, or Lower Shales. The lithological similarity of subdivisions 1 to 3, and 2 to 4 is so close, that it is only in an undisturbed section like that of Smoky River that their separate existence and relations could be ascertained. In the case of isolated exposures, it becomes very difficult to pronounce to which subdivision they should be assigned. Lithological resemblance of subdivisions

Rocks Exposed on Little Smoky River and the Athabasca.

Upper sandstones on Little Smoky. On the upper part of the Little Smoky River, where followed by us when travelling south-eastward from Sturgeon Lake, there are numerous exposures of soft earthy sandy shales, greyish or brownish, with greyish soft or nodularly hardened sandstones, the beds being horizontal where not disturbed by slides. Drift lignite was abundant in the stream, but was not obtained in the banks. The rocks are supposed to represent the south-eastern continuation of the Upper Sandstones and Shales.

Upper Sandstones on Athabasca. On leaving the Little Smoky, the country is entirely drift-covered to the Athabasca, but on this river exposures are frequent from the point where we reached it in longitude 116° 48′, for one hundred and ten miles, or to a point about fifteen miles below the site of Old Fort Assineboine. The river is rapid, and has a considerable rate of descent throughout this part of its length, but the rocks appear to slope eastward at nearly the same angle, so that no repetition of the fine section of Smoky River is here found. The beds exposed here belong also, it is supposed, to the Upper Sandstones. They consist of sandstones and shales, the former sometimes false-bedded and often nodular, and producing in some places scarped slopes and cliffs in the banks of the valley, the latter generally brownish and earthy, though in some beds greenish-grey and rather hard. **Lignite coal.** Lignite coal is frequently seen in the banks for about sixty-two miles above Fort Assineboine and several miles below that place. The exposure including lignite coal seen furthest up the river, showed, near the water's edge, the following section, in descending order:—

	Feet.	Inches.
Sandstones and Shales	—	
Shaly Lignite Coal	3	0
Soft Sandstone and Shale	4	0
Good Lignite Coal	1	8

Thick seams of lignite coal. About eight miles further down, in latitude 54° 11′ 40″ by observation, longitude 115° 56′, on the map accompanying this report, the most important deposit of lignite coal observed on the Athabasca was seen. Two beds here again occur, and are probabably the same with those above mentioned. They are shown near the water's edge in a slide detached from the main bank. The upper seam here has a thickness of ten feet, without including in this measurement about six thin shaly partings, which make up in all about ten inches of shale. Below this seam is about twenty feet of soft earthy sandstone and shale, followed by a second seam of clean hard lignite coal three feet in thick-

ness. The upper seam contains, according to Mr. Hoffmann, 11·47, the lower 10·58 per cent. of water. This percentage of water, though more than in the Pine River Forks and Mountain of Rocks coals, is far below that of the Souris region.

Further down the river, lignite coal is again seen in two thin seams, which occupy the same horizon, and the persistently coal-bearing character of the formation is thus evidenced, though the only workable seams noticed are those above mentioned. The seam occurring a few miles below Old Fort Assineboine is but four inches in thickness. The announcement of the existence of coal seams on the Athabasca was first made by Dr. Hector, who travelled up this river in the winter of 1859.

No exposures of the rocks underlying the drift deposits were found lower down the Athabasca than about fifteen miles below Old Fort Assineboine, though disturbed shales with some ironstone were noted in a few places in slides, below the mouth of the Lesser Slaver Lake River, and may indicate that rocks similar to those above described continue to occur in some of the high banks of the valley. A small exposure of sandstone was found in one locality on the north bank of Lesser Slave Lake by Mr. McConnell, and fragments of lignite occur in the bed of a large stream coming from the north near the east end of the lake. Impure lignite and sandstone also appear on the Swan River and at Deer Mountain south of Slave Lake, according to Mr. Horetzky; but with these trifling exceptions no indication of the character of the beds underlying this eastern part of the region was obtained on the routes travelled to Lac La Biche and Edmonton. **Last exposures on the Athabasca.**

NOTE TO COMPARATIVE TABLE OF CRETACEOUS ROCKS.—In Column IV, the position of the rocks of the localities mentioned in the lowest subdivisions is uncertain. In Column V, the correspondence of the Upper Shales to the Pierre Group may be regarded as quite definitely fixed. The Productive Coal-measures in Column VII and the Chico in Column VIII, are also known to represent the Pierre horizon, while the precise equivalency of the beds overlying the Productive measures remains uncertain. In the Queen Charlotte Islands, series C. is highly fossiliferous, and its position, as indicated, may be assumed as correct, while the time covered by the overlying and underlying beds is uncertain.

COMPARATIVE TABLE OF CRETACEOUS ROCKS.

I. England, &c.	II. Nebraska and Missouri River.	III. Rocky Mountain Region. 40th Parallel.	IV. Plains between 49th Parallel and Saskatchewan. (Boundary Commission Report.)	V. Peace River. (Smoky River Section.)
	Fort Union and Judith River Beds.	Laramie. 1500 to 5000.	Souris Lignitic and 'Lignite Tertiary' generally. α & β. Bad Lands section.	
Mæstricht & Faxoe Beds.	No.5 Fox Hill. 500.	Fox Hill. 1500 or more.	Division γ. Bad Lands section, also at White Mud River, Three Buttes, etc., Elbow of S. Saskatchewan-Qu'-Appelle Valley, Eyebrow Hill, etc.	Upper Sandstones and Shales. (Wapiti Riv. Group.) 200 feet or more.
White Chalk.	No.4. Pierre. 700.	Pierre. 250 to 300.	Pembina Mt. Series. Division δ. of Bad Lands section, also on Lower Souris, Assineboine, Qu'Appelle, Elbow of S. Saskatchewan. Series B. and C. (Hector) N. Saskatchewan West to Ft. Pitt, N. slope Cypress Hills, etc.	Upper Shales. (Smoky Riv. Group.) 350 feet.
Chalk Marl.	No.3. Niobrara. 200.	Niobrara. 100 to 200. Colorado Group. 600 to 1000.	Limestones of Boyne and Swan Rivers, marls of Thunder Hill. Series below No. 4 on E. Branch Milk River, Hector's Series D. (?) on Battle River, Red Deer River, Hand Hills, etc.	Lower Sandstones. (Dunvegan Group.) 100 ft.
Upper Greensand.	No. 2. Benton. 800.	Benton. 200 to 450.	Saskatchewan at Cole's Falls (?)	Lower Shales. Ft. St. John Group. 250 ft. or more.
Gault.	No. 1. Dakota. 400.	Dakota. 200 to 300.	Hector's Series E., with lignites (?) Red Deer R., N. and S. Saskatchewan, etc. (?)	
Upper Neocomian.	....	....	....	....

COMPARATIVE TABLE OF CRETACEOUS ROCKS.—*Continued.*

VI. British Columbia. (Interior.)	VII. British Columbia. (Coast.) Nanaimo.	 Comox.	VII. California.
	Sandstones 3294 Shales..... 960	Upper Conglomerate .... 320 Upper Shales...... 776 Middle Conglomerate .... 1100 Middle Shales..... 76 Lower Conglomerate .... 900 Lower Shales...... 1000	Tejon.
	1326. Productive Coal Measures 739.		
....			Chico.
		Queen Charlotte Isl'ds.	
Nechacco Series (?) Skeena sandstones with impure coal.	....	A. Upper Shales and Sandstones....1500 B. Conglomerates .....2000 C. Lower Shales and Sandstones....5000	Shasta.
Iltasyouco beds, 10,000. Skeena volcanic series. Porphyrite series. (?)	....	D. Agglomerates .....3500 E. Lower Sandstones....1000	
Aucella beds of Tatlayoco, Jackass Mt. and Skagit. 7000 or more. Porphyrite series. (?)	Beds of Forward Inlet, Quatsino Sd., Vancouver Island.		

GENERAL RELATIONS OF THE ROCKS OF THE PEACE RIVER REGION.

Composition of the Rocky Mountains.

The composition of the Rocky Mountains about the head waters of Peace River and its tributaries, has been described in such detail as our knowledge warrants in the preceding pages. The mass of the range appears to be composed of limestone, in which the only fossils found are with little doubt classed as Devonian. It remains uncertain whether in this part of the range any limestones of Carboniferous age comparable with the *Fusulina* limestones of Stuart Lake occur, but it is exceedingly probable that this is the case. To the west these limestones are supposed to be overlain by the Misinchinca schists, to the east by the Triassic *Monotis* beds, and it is at least possible that these overlying beds of the two sides of the range may eventually be found to be more or less strictly representative.

Limestones and quartzites.

The thickness of the limestones must be great, but remains indeterminate. They appear to be underlain by massive quartzites, which must be exposed on the north branch of Pine River, and are described as forming the lower part of Mount Selwyn on the Peace.*

Triassic rocks.

Devonian and Carboniferous limestones with quartzites, are extensively displayed in the Rocky Mountain Ranges between the Peace River and the 49th parallel, and it is probable that subsequent investigation will develope the essential identity of the lower part of the section throughout this region. An important difference is found, however, in the absence of the overlying Triassic red beds with dolomitic sandstones and impressions of salt crystals, which evidence the existence on the 49th parallel and southward, of areas shut off from the ocean. To the north the beds representing these in stratigraphical position are the *Monotis* shales from which it would appear that at that time the open sea flowed over the Peace River country.

Cretaceous basin of the Peace River.

In the Peace River country as a whole, little altered Mesozoic rocks chiefly or entirely of Cretaceous age, occupy a width of about 330 miles, stretching from the eastern base of the Rocky Mountains eastward to a point near the Falls. The Palæozoic rocks appear to be concealed throughout this distance, but Devonian limestones and gypsum beds emerge on the Peace River below the point just indicated, forming a portion of the belt of Devonian, and possibly in places Silurian rocks, which runs from the Clearwater and Athabasca Rivers north-westward to the west end of Great Slave Lake. From the head waters of the Peace River the Rocky Mountains would appear to run nearly due north, impinging on the Mackenzie at its bend, below the mouth of the Liard. At this point the Mesozoic basin, which has been gradually narrowing northward by the convergence of its Palæozoic

* Report of Progress Geol. Survey of Canada, 1875-76, p. 80.

borders, is either interrupted, or at least very much constricted. Trustworthy information concerning this northern region is however almost confined to Sir J. Richardson's necessarily brief account of it.

Fragments of limestone holding Devonian fossils are more or less abundantly scattered over the whole Mesozoic region. In some of these found by myself on the Wapiti River, Mr. Whiteaves finds the following forms:— Drift-fragments of Devonian limestone.

Atrypa reticularis, Linn.
Loxonema. Casts of a small species.
Euomphalus. One cast of a small species.
Orthoceras. Fragments.

In loose stones found by Mr. McConnell on the Battle River, north of Dunvegan, the following species are represented:—

Acervularia profunda, Hall. According to Rominger (Foss. Cor. Mich., p. 106) this is a synonym of *Cyathophyllum Davidsoni*, Milne Edwards.
Atrypa reticularis, Linn. Abundant and well preserved.
Orthis —? Two small specimens.
Modiolopsis (?) Sp. Cast of a right valve.
Pterinea, Sp. Undt. Two or three specimens.
Pleurotomaria (?) —? Casts.
Naticopsis lævis? Meek. One example.
Naticopsis —? Several casts of a species very different to the preceding.
Bellerophon. Species indeterminable.
Orthoceras —? Fragments.
Calymene. Cast of the glabella of a small species.

In the annexed comparative table the equivalency of the principal western American representatives of the Cretaceous is displayed with as great accuracy as present information allows, the region north of the 49th parallel, in British Columbia, and the North-west Territories, of a portion of which the present report treats, being exhibited in the greatest detail. It will be observed that the Lower or Fort St. John Shales of the Peace River region are supposed to be equivalent to the Benton Group of Meek and Hayden's section, in a general way, while the Lower or Dunvegan Sandstones are assumed to be the representatives of the Niobrara, and the Upper Shales are without doubt referable to the Pierre Group. As the overlying Fox Hill beds, in the Rocky Mountain and Missouri regions, are conformable not only with the Pierre below but with the Laramie and Fort Union above, and as no fossils have been found in the Upper Sandstones of the Peace River country, it is impossible at present to tell whether this subdivision represents the Fox Hill Group alone or this and the Laramie. Correlation of Cretaceous sub-divisions.

In making these comparisons it must, however, be borne in mind that Meek and Hayden's section, though well marked in Nebraska, is

Change in character of Cretaceous westward.

not found to be strictly applicable further west, in the vicinity of the Rocky Mountains, and that owing to the difficulty of tracing the subdivisions in that region, Messrs. King and Hayden have agreed to name the Pierre, Niobrara and Benton Groups together, the Colorado Series. A similar change to the westward occurs north of the 49th parallel. This has already been referred to in my report on the Geology and Resources of the 49th parallel, and is found in the Peace River region even more markedly. The vicinity of the land of the Rocky Mountains, which here even at this early time existed, has given rise to the formation of thick sandstones and conglomerates, while land surfaces have occurred during the deposition of both the Lower and Upper Sandstones.

Estuarine and Terrestrial conditions.

The occurrence of an estuarine and fresh-water fauna in a horizon of the Cretaceous nearly equivalent to the Niobrara, is a circumstance of great importance, and it is particularly interesting to find that the fresh-water forms resemble so closely those of the Laramie group, and have such a decided Tertiary aspect. The occurrence is analogous to that known at Coalville, in Utah, where it would appear that at a period of the Cretaceous only a little later than that of the Dunvegan Sandstones, a stream must have brought numerous fresh-water forms into the edge of the Cretaceous sea. Instead of a merely local development of such conditions, however, we have in the Peace River country a widely extended subdivision of the Cretaceous of persistent fresh-water and estuarine character, which when properly studied, will add largely to our knowledge of the Cretaceous fauna. The occurrence of

Fossil plants.

plants in the same beds also helps to bridge over the interval previously existing between the Dakota and Vancouver Island (Chico) and Laramie floras.

Estuarine Cretaceous beds in Utah.

Of the locality already referred to in Utah, where fresh-water and marine shells are found together in association with valuable beds of coal, Prof. Meek writes*: "The group of fossils found in the dark indurated clay G is, in several respects, a very interesting one, not only because every species is new to science, and all of them entirely different from any yet found at any other locality, or even in any other beds of this locality (with possibly one or two exceptions), but on account of their modern affinities. Here we have from beds certainly overlaid by more than 1000 feet of strata containing Cretaceous types of fossils, a little group of forms, presenting such modern affinities that, if placed before any palæontologist unacquainted with the facts, they would be at once referred to the Tertiary."

In regard to the circumstances of deposit of the several subdivisions

* U. S. Geol. Survey of Territories, 1872, p. 445.

of the Cretaceous of the interior region of the continent, a somewhat detailed note may be found in the report of the 49th parallel already referred to (chap. vii.). With the light since thrown on the subject by the examination of the Peace River region, the following summary may be presented. Conditions of deposit of Cretaceous rocks.

Dakota period. It would appear that the Cretaceous opened with a period of considerable land surface, shallow waters, and current-driven sandbanks, and that these circumstances not only extended from the Nebraska region westward to the Wahsatch Mountains, but probably also northward to the Saskatchewan region, and possibly to the Peace River country, though no beds so low as the Dakota series have yet been recognized here. Similar conditions affected the Mississippi region, described by Prof. Hilgard, and probably at the same time the Cretaceous coast-deposits of New Jersey.

Benton period. This seems to have have been followed in the interior continental region, by a general subsidence, during which the Benton shales were formed, the great quantity of fine material required being, probably, brought into the region owing to the opening by the depression of wide avenues to the north through which currents flowed southward, these shales are now known to occur northward to the Saskatchewan and Peace River districts. During a succeeding period of tranquility, in which but a small amount of detrital matter was introduced, the chalk-like Niobrara limestones of the Nebraska region were formed. These have now been found in several places along the eastern exposures of the Cretaceous north of the 49th parallel. In the Rocky Mountain region the Niobrara was a period of elevation, and calcareous beds are not so important; and it would now appear, if the correlation adopted in the table be correct and the Dunvegan Sandstones represent the Niobrara Group, that in the region of the Peace River the elevation gave rise to widely extended tracts of low land. Here probably we find the land barrier which shut out the northern currents with the sediment which they may be supposed to have carried. Niobrara period.

Pierre period. In the Pierre shales, exceedingly fine in texture and of great thickness, we have evidence of a second considerable subsidence, which by again allowing the region to be traversed by marine currents, and perhaps also by bringing neighbouring decayed land surfaces under the action of the sea, supplied the necessary material. During this period, according to Meek and Hayden, a part of the clays and greensands of New Jersey were formed on the Atlantic coast; and in the Mississippi region, according to Hilgard, the Rotten-limestone Group was deposited. The fact that calcareous beds were being formed in the southern portion of the interior continental trough, while deposits so purely argillaceous were produced in the northern, seems to verify the supposition

of the entrance of the sediment-bearing waters from the north. On the west coast, the subsidence appears to have allowed the Chico beds to spread to the foot of the Sierra, while land surfaces in Vancouver Island were brought down to the sea-level, and vegetable accumulations formed and covered by marine strata, giving rise to the valuable coal deposits of that region. Here the subsidence must have continued for a long period, while several thousand feet of strata were laid down.

Fox Hill period. In the interior continental region, either elevation followed the Pierre period, or the increase of sediments proceeded faster than the slow subsidence, for the succeeding Fox Hill period is again characterized by sands and similar shallow-water accumulations; and between the Rocky Mountains and the Wahsatch, near the western margin of the sea, land surfaces, evidenced by the occurrence of coals, existed. That the decreased depth over the interior continental region was due mainly to the filling up of the northern portion of the basin, rather than to elevation, seems to be indicated by the fact that limestones and marlites still continued to be deposited in the Mississippi region.

Laramie period. During the deposition of the Upper Cretaceous, Transition or Eocene beds of the Laramie and Fort Union series, depression must have been steadily in progress, for while land surfaces are evidenced at many horizons, the thickness of the formation is very great. The accumulation of material, however, outstripped the slow sinking, for during this period marine conditions came to an end, the salt water being first excluded from the eastern, afterwards from the western part of the area.

Coal-Bearing Character of the Peace River Rocks.

Two coal-bearing horizons. In both the horizons characterized by sandstones in the Peace River district, coal occurs, and while as above stated the upper may in part represent the Laramie, the lower is certainly well down in the Cretaceous formation. This in itself is a point of considerable importance, showing that the carboniferous character of the rocks is not confined to a single series of beds, but recurs at two stages. It also probably confirms the view advanced by Dr. Hector and supported by Mr. Selwyn, for the Saskatchewan country, as to the existence of a coal-bearing horizon in the Cretaceous of that region, in addition to that of the Tertiary or Laramie age.

Probable occurence of workable seams. It would thus appear, that while in the region lying between the Athabasca and the Peace Rivers, no coal seams sufficiently thick to be of great economic value have yet been discovered, that coal and lignite of good quality occur in two distinct series of beds. Wherever natural sections of these occur in the valleys of rivers and streams, coal

in greater or less quantity is found, and the persistently carboniferous character of the beds thus abundantly proven. There can be little doubt that beds of a workable character exist in different parts of this district and will be found by further search.

Western coal-bearing belt.

The promising coal-bearing belt of rocks, supposed to belong to the Lower Sandstones and Shales, which runs south-eastward from the Cañon of the Mountain of Rocks to Table Mountain and the Lower Forks of Pine River, probably extends still further in the same direction, crossing the head-waters of the Wapiti and Smoky Rivers above the points reached in my exploration, and forming the south-western side of a synclinal in which the Upper Sandstones and Shales lie. In this the coals reported by the Indians to exist on the upper parts of these rivers may occur.

Coals on the Pembina and Saskatchewan.

On the extension of these formations to the south-eastward, a bed of coal, reported to be eight feet in thickness, occurs near the projected railway crossing of the North Pembina River, while between Fort Edmonton and the mouth of the Brazeau River, on the Saskatchewan, a seam of coal from fifteen to twenty feet in thickness was discovered by Mr. Selwyn in 1873; * and other thick seams are reported on the upper part of the Brazeau.

An analysis of the fuel from the North Pembina River made in 1874, by Prof. Haanel, gives the following composition:—

Water	11·88
Volatile combustible matter	28·66
Fixed carbon	57.25
Ash	2·21
	100·00

The coal collected by Mr. Selwyn at the place above referred to on the Saskatchewan yielded to Dr. Harrington the following result on analysis by slow coking:—

Water	10·09
Volatile combustible matter	28·69
Fixed carbon	54·96
Ash	5·45
	100·00

While neither of these can be classed as true bituminous coals, they are fuels of great value, and compare closely with those brown coals used extensively on the line of the Union Pacific Railway in the Rocky Mountain region.

* Report of Progress, Geol. Survey of Canada, 1873-74, p. 49.

Ironstone.

In many localities on the Peace River, and between that stream and the Athabasca, clay ironstone in nodules and nodular sheets is abundant; but generally not in such quantity as to justify a belief in its economic importance. On the lower part of Smoky River, however, as already mentioned, great quantities of ironstone of excellent quality might be collected from the bars and beaches.

GLACIATION AND SUPERFICIAL DEPOSITS.

Descent of ice by Skeena Valley.

In the report of 1878-79 it was stated that during the period of glaciation the glacier ice of the mainland probably extended to the outer islands of the Coast archipelago, and the evidence of the passage of ice over the Gnarlod Islands lying in Dixon's Entrance, north of Dundas Island was noted. (p. 97 B.) The valley of the Skeena must have been one of the larger troughs by which the ice descended from the continental land, and in following the valley up, we find accordingly the traces of the seaward progress of the glacier.

On the rocks of the little promontory at Port Essington, heavy and well marked glacier grooving was observed below high-tide mark, the exposed portion of the surface being roughened by weathering. For more than forty miles up the river from this point, the rocks were very frequently noticed to be striated and grooved, while the slopes of the larger projecting masses are sometimes such as to show the effect of ice action on the mountain sides at 3000 feet above the water. Smooth glaciated surfaces are seen, however, only when the slopes have been comparatively lately bared by slides.

Signification of terraces.

The signification of terraces on the sea coast is sufficiently clear, as indicating a former depression of the land, but on going inland, in a mountainous country, their meaning is by no means so easily understood. In a valley like the Skeena, glaciers may at various times have pressed so far across it as to dam back the waters and bring about the formation of terraces without any necessary alteration of the level of the land, or mere river terraces may be mistaken for traces of change in elevation. The singular absence of extensive detrital deposits along the coast, has already several times been referred to in previous publications, and those of the Queen Charlotte Islands and vicinity of Port Simpson are described in the report for 1878-79.

Terraces on Skeena.

About eighteen miles above Port Essington, on the Skeena, a somewhat extensive terrace-flat with an elevation of about 200 feet was noted, but with this exception, and that of the gravel and silty deposits of the low flats through which the river winds, no detrital deposits of importance were observed till the mouth of the Kitsumgalum River was reached. A hard gravelly deposit rising about twenty feet above the

river here occurs, and floors a portion of the wide valley which at this place crosses that of the Skeena. Above Sĭp-kĭ-wa rapid, terraces of gravel twenty to thirty feet in height were again observed to border the river. Between Kitsalas and Kwatsalix Cañons similar deposits are seen, and terraces to a height of 170 feet above the river were found in one place. On continuing to ascend the river the amount of detrital matter and breadth of terraces increase. At Kit-wan-gah, terraces with a probable height of 200 to 500 feet were observed, while on a mountain side below that place a terrace was noted at least 1500 feet above the stream. Near the mouth of the Kitseguecla some material resembling typical boulder clay occurs

In crossing from the Forks of Skeena to Babine Lake, the rocks were observed to be glaciated in one place near the head waters of the tributaries of the Sus-kwa, the direction being westward, or down the valley. The summit passed over by the trail is formed by a wide terrace-flat, sloping gently southward. Its surface is strewn with rounded and sub-angular blocks of varied origin. Its height is about 4300 feet, and its character implies the somewhat prolonged action of the water at this level. Smaller terraces clinging to the slopes of the valleys were observed at several places immediately west of this summit, and one of these was estimated to have an elevation of about 4900 feet.

Glaciation in Babine Mountains.

High terrace.

About the shores of Babine and Stuart Lakes, superficial deposits are largely developed. Behind the Hudson Bay post at the north end of Babine Lake, two terraces were observed, the lower 160 a second 200 feet above the lake. The first of these is very well marked in many places further up the lake. On the slope of the Na-tal-kuz Mountain, terraces estimated at 800 to 1000 feet above the lake occur. Similar terrace-flats spread widely on the north-east side of Stuart Lake, and the old water-lines are even clearly shown in the cutting back of the limestone rocks near Fort St. James in a step-like manner at various elevations. The country over which the portage between the lakes is made, is for the most part a terrace-flat, with an elevation of about 400 feet above Babine Lake.

Babine and Stuart Lakes.

The white silt deposit of the Nechacco region, described in the report 1876-77, is not found in the valley holding Stuart and Babine Lakes, except at Fort St. James, at the southern extremity of the former. Strong currents or other causes may have prevented its deposition, but it is quite clear from the terraced character of the sides of François, Fraser, and the two lakes just mentioned, that these formed at one time arms and bays of an extended and gradually subsiding sheet of water, in which, in the Nechacco region, the white silts were being laid down.

White silt deposits.

Glacial striation.

On the hills behind the Hudson Bay post at the north end of Babine Lake, the rocks show striation in a bearing of S. 24° E., which is that of the valley. The direction of movement has probably been from north to south. On the vertical face of the low cliffs of a small island more than half way up the lake, glaciation was observed. This was evidently the result of glacier ice passing southward between the island and the main shore, and pressing upward as the degree of constriction of the passage became greater. The little island at the mouth of the Yi-ko River at the head of Stuart Lake is also glaciated, and apparently indicates a direction of movement from S. 10° E.

Terraces.

The country between Stuart and McLeod Lakes has already been described as a deeply drift-covered region, rising at the Pacific-Arctic watershed to a height of 2820 feet, and lying to the north of and at a greater elevation than the white silt plain of the Lower Nechacco. The surface is generally undulating, or stretches out in wide terrace-flats, the whole indicating a general submergence as the condition for its formation. Near Carp Lake, and elsewhere, are some remarkable pot-holes, in a few cases nearly one hundred feet deep and with very steep sides. These are probably due to the simultaneous action of water and the retreating edge of a glacier, which has left pretty evident tokens of its extension into this region in the broken ridgy country found on both sides of Iroquois Creek. There can be little doubt that these ridges represent moraines, and the contemporaneous action of water is here again indicated by the presence of terraces among them. The glacier producing these moraines must have pushed thus far westward from the valleys of the Rocky Mountains.

Pot-holes and moraines.

Material of drift.

The material of the drift of this region is very varied in origin, including besides rocks probably referable to the Cache Creek Series, some of Mesozoic and Tertiary origin, and also a considerable proportion of 'Quartzite drift.' On approaching McLeod Lake, the latter preponderates and is eventually found almost to the exclusion of other material. This 'Quartzite drift' was found in a former season largely developed near Fort George, and is now definitely ascertained to have come from the Rocky Mountain ranges.

Misinchinca and Pine Pass.

On the Misinchinca River, with the exception of comparatively low terraces bordering the stream, drift deposits appear to be scantily represented, though in the valley of its tributary, the Atunatche, by which the summit of the Pine Pass is reached, the slopes are in some places heavily covered with earthy material. Rolled stones are also found several hundred feet up the mountain side above the actual summit of the Pass, and on the south-west side there appears to be a terrace at a height of 300 to 500 feet. Glaciation was observed in two or three places on the Misinchinca. The rocks are distinctly glacier marked

where the trail crosses the river, the direction being parallel to that of the valley. At the foot of the precipice on the north side of the summit, the rocks show glaciation in a bearing of N. 60° W.

Absence of drift on Upper Pine River.

In the upper part of the valley of Pine River, no rock striation was observed, though this would probably be found by more careful search. The soft character of the rocks is not favourable to the preservation of such marks. Drift deposits appear, however, to be almost entirely absent, and though the sides of the valley in many places simulate terraced forms, this is found to depend on the outcrop of the nearly horizontal sandstone beds. The upper part of the river is paved with glistening fragments of shistose and generally micaceous rocks derived from the mountains. The large tributary entering at the Upper Forks brings with it little but quartzite, which from its superior hardness and resistance continues to prevail on the lower reaches of the main river, the sandstone rocks disappearing.

Terraces on Lower Pine River.

About twenty-eight miles above the Middle Forks, terraces of rolled gravel and fine silty sand begin to appear, one of the best marked being about 170 feet above the river. The plateau in which the river valley is excavated has a height of about 1000 feet above the river, or 3000 feet above the sea. It is not here thickly covered with drift material, but there are many water-rounded stones, a large proportion of these being hard quartzite pebbles like the more resistant materials of the axial range of the Rocky Mountains. These are mingled with a preponderating number of fragments of the softer sandstones of the country, and imbedded in a whitish or cream coloured silty clay, not unlike the material representing the boulder clay over wide districts west of the Rocky Mountains. No Laurentian or other fragments of eastern origin were observed in this region. The character of the plateau changes about the Lower Forks, and instead of showing a comparatively thin covering of drift deposits, the surface of the country is composed to a great depth of such material, the plateau having an average elevation of about 2400 feet. On Coal Creek, sections show in some places 150 feet of drift deposits resting on the Cretaceous beds, the lower part is generally gravelly and holds boulders, while the upper is a fine silty deposit. The route followed passes over the northern spurs of the higher plateau country which is attached to the foot hills to the south and west, crossing a summit of 3300 feet between Coal and Buffalo Creeks. No change in the character of the drift deposits was noted, but on reaching the D'Echafaud River, Laurentian pebbles and boulders were for the first time seen in considerable abundance. The elevation of the D'Echafaud River at this point is 2030 feet, but as the boulders now in the river bed have evidently been derived from the material of the plateau through which it is cut, the level at which

Drift material.

Heavy drift covering.

Laurentian fragments.

the Laurentian drift may be said to begin in this region must be about 2300 to 2500 feet.

Peace River plateau. East of this point, the general character of the country in regard to its superficial deposits is so uniform that it is scarcely necessary to particularize localities in describing it. The surface is thickly covered with drift deposits, so much so that exposures of the underlying rocks are, as a rule, only found in the larger river valleys. The lower layers of the drift probably represent the boulder clay of the plains to the south and east, and northern part of British Columbia to the west. They are sandy clays with stones and boulders in greater or less abundance, and their upper surface is somewhat irregular, rising in some places in ridges or broad gentle elevations which stand out above the newer silty deposits. The latter have already been spoken of in connection with the soil of the district, and cover by far the greater area of its surface. The silt is generally pale grey or fawn colour, and very fine, in some places changing to a clay, and elsewhere becoming a fine sand. A stretch of sandy country of this kind borders the lower part of the Wapiti River, and in ascending gradually toward the Athabasca, and southern rim of the Peace River basin, the silt becomes coarser and eventually sandy. During the submergence to which the deposit of the silt is due, these places must have been swept by stronger currents, preventing the finer material from falling to the bottom. The average elevation of the plateau is somewhat greater than 2000 feet, but the degree of submergence required to account for the distribution of boulders over its higher parts near the Athabasca River is at least 3300 feet. The occurrence of Laurentian boulders at this height near the Athabasca, renders it difficult to understand their apparent absence, or at least rarity, in the region about the Middle and Lower Forks of the Pine River.

Boulder clay.

Silt.

Submergence required.

Material of drift. In regard to the material of the drift, the stones and boulders scattered over this great district are in part those of the Rocky Mountains, in part derived from the Laurentian axis to the north and east. The fragments from the first-mentioned source are generally of hard quartzites, the limestone and other softer rocks found abundantly in the immediate vicinity of the mountains decreasing rapidly as we recede from them, and eventually all but completely disappearing. This circumstance is also observed in the vicinity of the 49th parallel.* The Laurentian material is chiefly gneiss and granite of the usual well marked types, and as above stated is still abundant at an elevation of about 3300 near the north bank of the Athabasca, at the watershed between that river and the Peace. Laurentian boulders were noted as

* Geology and Resources of the 49th parallel, p. 246.

abundant in the lower part of the Smoky River, and some particularly large ones on the Athabasca between the mouth of Lesser Slave River and the Landing.

Between the Landing and Edmonton, Laurentian boulders are in some places exceedingly numerous, but quartzite from the Rocky Mountains is still present. The sandy hills forming the watershed between the Athabasca and Saskatchewan, with an elevation of about 2500 feet, in their forms and material show evidence of strong current action.

Question of mode of glaciation.

The circumstances causing the glaciation of British Columbia and the sequence of the various phenomena have been discussed in previous reports, and in the Quarterly Journal of the Geological Society.* It will consequently be unnecessary to recapitulate the details of evidence collected in various regions, but it may be stated that the main question seemed to resolve itself into two possible cases. A general north-to-south movement of ice is indicated by striation in a number of places extending over a length of about 450 miles in the interior plateau region. The same region is covered with drift deposits requiring by their character and mode of arrangement the action of water from elevations exceeding 5000 feet downward. To account for these facts, the flow of strong Arctic currents bearing heavy ice during a period of great submergence may be supposed, or it may be necessary to believe, that the whole region has been buried under a massive confluent glacier, the drift deposits being laid down as it retreated either during a period of submergence, or in water held back by glacier-dams in the valleys of the various mountain ranges.

No access for ocean currents.

It was supposed that the gaps of Peace and Pine Rivers in the Rocky Mountain ranges, might have sufficed for the entrance from the north-east of such currents and masses of ice as would be required by the first theory. But the examination of the region with this supposition in view, has convinced me that notwithstanding the general decrease in elevation and width of the Rocky Mountains, the valleys of the Peace and Pine are too narrow and indirect, and the surrounding mountains too high, to allow the inflow of sufficient currents with the degree of subsidence which would be indicated by most of the localities of glaciation and by the superficial deposits. Neither is there any evidence of the passage of drift material in this region across the mountains either from east to west or in the opposite direction. It therefore remains as the most probable hypothesis that a great glacier mass has filled the region between the Coast Ranges and Gold and Rocky Mountains, which may be designated as the interior plateau, moving, though perhaps very slowly, southward and south-eastward from the

Probable great glacier of British Columbia.

* Report of Progress Geol. Survey of Canada, 1877-78, p. 150 B, 1878-79, p. 98 B. Quart. Jour. Geol. Socy., 1878, p. 117.

region of great precipitation and high mountains of the northern part of the province, and discharging by the Okanagan depression and through the valleys of the Coast Range.

Probable general submergence. It still appears to me most probable, however, that this stage of the glacial period was closed by a general submergence, during which the deposit spoken of as boulder clay was laid down, and as the land again rose many of the terraces and benches were formed. Conditions may be invented to account for the temporary existence of a great lake over the Interior Plateau of British Columbia, but this will not explain the great submergence which appears to be required by the drift-deposits of the east side of the Rocky Mountains, which were probably produced at the same time and by the same agencies. **White Silts.** The last stage of the glacial period in the northern low country of British Columbia appears to have given rise to the silts of the Lower Nechacco basin, while to the north-east, on the opposite side of the Rocky Mountains, similar deposits were laid down over the Peace River country. The general elevation of the white silt plains of the Nechacco is somewhat less than 2600 feet, of the Peace River country between 2000 and 2500 feet.

The general question of the origin of the drift-deposits of the great plains, and more particularly of the western portion, having been fully discussed in the Geology and Resources of the 49th Parallel, and in a paper communicated to the Geological Society of London,* it will be unnecessary to enter at length into it here. **The Coteau.** The most prominent feature of the glacial deposits of the plains is the Missiouri Coteau, which it was supposed ran northward from the region in the vicinity of the 49th parallel where it was more particulaly studied, nearly following the margin of the third prairie steppe. This supposition has since been in great measure confirmed, and on the journey from Edmonton to Winnipeg in the Autumn of 1879, I was able to examine cursorily the character of the third prairie steppe where it touches the north Saskatchewan near the Elbow, and to observe the great accumulation of heavy boulders of eastern and northern origin in that vicinity. Further north, with the general lowering of the surface of the country, the well defined zone of drift deposits known as the Coteau appears to be lost, the material being scattered broadcast over a wide surface, and approaching in considerable mass the high lands near the base of the Rocky Mountains. **Mingling of drift from east and west.** It will have been observed, however, that over the entire area examined, the material from the Rocky Mountains has also been strewn eastward, implying a sea in which ice bearing debris both from the Laurentian Axis and Rocky Mountains floated freely. This at least appears to be the only mode of accounting for the distribution of the material forming the drift in this northern part of the region of the plains, as well as in that to the south previously studied.

* *Op. cit.*, p. 218, *et seq.* Quart. Journ. Geol. Soc. Vol. XXXI, p. 603.

APPENDIX I.

List of Plants Collected in the Northern Part of British Columbia and the Peace River Country, 1879.

Prof. J. Macoun, of Albert College, Belleville, has kindly determined the plants, of which the following is a list:—

Ranunculaceæ.

Ranunculus nivalis R. Br.; var. Escholtzii, Schlecht. Summit Pine Pass, July 27.
Aquilegia formosa, Fisch. Stuart Lake, July 2.
Delphinium scopulorum, Gray. Iroquois Creek, July 10.
Aconitum Napellus, L.; var. delphinifolium Seringe. Misinchinca River, July 23.

Fumariaceæ.

Corydalis aurea, Willd. Pine River, August 1.

Cruciferæ.

Arabis Drummondii, Gray. Iroquois Creek, July 12.
Erysimum cheiranthodes, L. McLeod's Lake, July 16.
Arenaria lateriflora, L. Stuart Lake, July 2.
Draba alpina, L.; a large form. Summit Pine Pass, July 27.

Linaceæ.

Linum perenne, L.; seed. Pine River, August 4.

Geraniaceæ.

Geranium Richardsoni, Fischer and Meyer. Summit Pine Pass, July 27.

Leguminosæ.

Lupinus polyphyllus, Lindl. Swamp River, July 10; very abundant.
Astragalus alpinus. L. Summit Pine Pass, July 27.
Oxytropis campestris, DC.; var. melanocephala, Hook. Skeena River, June; Summit Pine Pass, July 27.

Hedysarum boreale, Nutt. Summit Pine Pass, July 27; Dunvegan, August 13, flower and seed.
Hedysarum Mackenzii, Rich. Iroquois Creek, July 10.

ROSACEÆ.

Spiræa Aruncus, L. Misinchinca River, July 24.
Spiræa betulifolia, Pall. Iroquois Creek, July 11.
Poterium Canadense, Benth. Misinchinca River, July 23.
Dryas octopetata, L. var. Drummondii, Wat. Skeena River, June; also Pine River, August, in seed.
Geum rivale, L. McLeod's Lake, July 16.
Geum strictum, Ait. Near McLeod's Lake, July 9.
Potentilla arguta, Pursh. Near McLeod's Lake, July 9.
Potentilla Anserina, L. McLeod's Lake, July 16.
Potentilla Hippiana, Lehm. Pine River, August 4.
Rubus Chamæmorus, L. Lower Skeena, June.
Rubus pedatus, Smith. Misinchinca River, July 21.
Rubus arcticus, L. Near McLeod's Lake, July 9.

SAXIFRAGACEÆ.

Parnassia palustris, L. Misinchinca River, July 21.
Saxifraga tricuspidata, Retz. Skeena River, June.
Heuchera hispida, Pursh. Dunvegan, August 13.
Heuchera glabra, Willd. Misinchinca River, July 24.
Tiarella unifoliata, Hook. McLeod's Lake, July 16.
Tellima grandiflora, Dougl. Misinchinca River, July 23.

CRASSULACEÆ.

Sedum stenopetalum, Pursh. Summit Pine Pass, July 27.

ONAGRACEÆ.

Epilobium latifolium, L. Misinchinca River, July 25.

CAPRIFOLIACEÆ.

Symphoricarpus occidentalis, R. Brown. Pine River, August 4.

COMPOSITÆ.

Aster lævis, L. Dunvegan, August 17; very abundant.
Aster præcox, Lindl. Dunvegan, August 17.
Erigeron glabellum, Nutt. Pine River, August 4.
Solidago Virga-aurea, L,; var, humilis. Dunvegan, August 13.
Achillæa multiflora, Hook. Dunvegan, August 17.
Senecio eremophilus, Rich. Dunvegan, August 13.

Arnica foliosa, Nutt. Coal Brook, August 8.
Arnica amplexicaulis, Nutt. Pine River, August 1.
Arnica latifolia, Bong. Stuart Lake, July 3.
Hieracium Canadense, Mx. Dunvegan, August 17.
Macrorrhyncus glaucus, Watson; var. dasycephalum, T. and G. Iroquois Creek, July 11.

Ericaceæ.

Andromeda polifolia, L. Lower Skeena, June,
Kalmia glauca, Ait. Lower Skeena, June.
Rhododendron albiflorum, Hook. Misinchinca River, July 23. (On mountain 2000 ft. above the stream.)
Pyrola rotundifolia, L.; var. uliginosa, T. and G. Stuart Lake, July 2.
Moneses uniflora, Gray. Stuart Lake, July 2.

Scrophulariaceæ.

Penstemon confertus, Doug.; var. cæruleo-purpureus, Gray. Summit Pine Pass, July 27.
Pedicularis Grœnlandica, Retz. Summit Pine Pass, July 27.
Melampyrum Americanum, Mx. McLeod's Lake, July 16.

Labiatæ.

Monarda fistulosa, L.; var. mollis, Gray. Middle Forks Pine River, August 5.
Lophanthus anisatus, Benth. Dunvegan, August 17.

Borraginaceæ.

Mertensia paniculata, Don. Stuart Lake, July 2.
Myposotis alpestris, Hook. Summit Pine Pass, July 27.

Polomoniaceæ.

Collomia linearis, Nutt. Near McLeod's Lake, July 9.

Gentianaceæ.

Gentiana Amarella, L.; var. acuta, Hook. Pine River, August 1.

Orchidaceæ.

Habenaria dilatata, Gray. McLeod's Lake, July 16.
Habenaria elegans, Lindl. ? Swamp River, July 10.
Habenaria rotundifolia, Rich. Stuart Lake, July 2.
Goodyera repens, R. Br. Plateau between Pine River and Dunvegan, August 10.

LILLIACEÆ.

Zygadenus glaucus, Nutt. Summit Pine Pass, July 27.
Smilacina bifolia, Ker. McLeod's Lake, July 16.
Smilacina uniflora, Menzies. McLeod's Lake, July.
Allium cernuum, Roth. Pine River, August 4; Dunvegan, August 13, seed.

CYPERACEÆ.

Scirpus cæspitosus, L. ? Lower Skeena, June.

GRAMINEÆ.

Bromus ciliatus, L. Pine River, August 1.
Triticum repens, L.; var. laxa, Vasey. Pine River, August 1.
Elymus Sibiricus, L. Misinchinca River, July 24.

FILICES.

Botrychium Virginicum, Swz. Stuart Lake, July 1.

APPENDIX II.

METEOROLOGICAL OBSERVATIONS IN THE NORTHERN PART OF BRITISH COLUMBIA, THE PEACE RIVER DISTRICT, AND FROM EDMONTON TO MANITOBA, JUNE 7 TO NOVEMBER 28, 1879.

The barometer readings are those of a small aneroid, and therefore to be depended upon only as indicating relative changes of pressure. The temperature is stated in degrees Farenheit.

The force of the wind is estimated according to Beaufort's scale. The proportion of sky covered by clouds is estimated on a scale of 0 to 10, 0 being a cloudless, blue sky, 10 an overcast sky. The character of the clouds is denoted by the usual letters or combinations of letters referring to Howard's classification.

The state of the weather is denoted by the following letters:—*b*, blue sky; *c*, detached clouds; *d*, drizzling rain; *f*, fog; *h*, hail; *l*, lightning; *m*, misty; *o*, overcast; *p*, passing showers; *q*, squally; *r*, rain; *s*, snow; *t*, thunder; *w*, wet, meaning dew. A letter repeated denotes intensity, as *rr* much rain, and a figure attached duration in hours, as 7*d*, seven hours drizzling rain.

PLACE.	Date.	Hour.	Barometer.	Temperature of Air.	Maximum.	Minimum.	Direction of Wind.	Force of Wind.	Kind of Cloud.	Am't of Cloud.	Weather at Time.	Weather during Next Interval.	Remarks.
				°	°	°							
Port Essington	June 7	10 00 a m	30.27	.....	.....	.....	.....	...	C.K. & S.	10	.....	o, cc Westerly wind	
Skeena River	" 7	8 30 p m	30.22	53 0	.....	.....	Wes'rly	2	C.K.	1	.....	.....	
"	" 8	9 30 a m	30.12	47.0	.....	39.0	Wes'rly	1	——	0	.....	b, c; clouding	
"	" 8	6 00 p m	30.065	59.0	.....	.....	S.S.W.	3	K.	9	.....	o, calm, fair	
"	" 9	6 00 a m	30.105	48.5	63.0	49.0	——	0	S.	10	.....	o, nearly calm	
Skeena River (38 miles up)	" 9	6 00 p m	30.05	63.0	.....	.....	——	0	S. & K. S.	10	.....	o, calm	
" " "	" 10	6 00 a m	30.065	48.5	.....	46.5	——	0	S. & K. S.	10	Mist on h'ls	o, p	
Skeena River (48 miles up)	" 10	6 00 p m	30.10	63.0	.....	.....	Wes'rly	1	S.	10	" clr'g	cc	
" " " " "	" 11	6 00 a m	30.225	47.5	.....	46.0	E'st'rly	1	C.K.	9	" "	b, c, westerly wind	
Skeena River (58 miles up)	" 11	6 00 p m	30.175	56.5	.....	.....	——	0	K.S.	10	Fair.	o, p, calm	
" " " " "	" 12	6 00 a m	30.205	45.5	.....	44.5	S.W.	3	S. & K. S.	9	p	b, c, p, westerly wind	6.00 a.m., calm in valley; mist on hills.
Lakelse River	" 12	6 00 p m	30.17	61.0	.....	.....	W.S.W.	3	K. & K.S.	6	Fair	b, c, nearly calm	
" "	" 13	6 00 a m	30.215	40.0	.....	39.0	W.S.W.	?	K. & K S.	2	"	b, c, S.E. wind	6.00 a.m., calm in valley; clouds on hill-tops.
Mumford Landing	" 13	6 00 p m	30.775	52.5	.....	.....	E.S.E.	3	K. & K.S.	8	"	c, p	
" "	" 14	5 30 a m	30.110	44.0	.....	44.0	E'sterly	1	S. & C. S.	10	"	b, c, p, strong west wind.	5.30 a.m., clouds down on hills.
2½ miles below Kitsalas Canon (20' above river)	" 14	6 00 p m	30.045	52.5	.....	.....	W.S.W.	4	K. & C.K.	6	"	o	

" " " " "	"	15	8 00 a m	30.020	41.0	.....	40.0	———	0	S.	10	r.	3r, o, westerly wind	
" " " " " "	"	15	6 00 p m	30.07	47.5	.....	.....	W.	2	S. & C. S.	10	Fair	o	
" " " " " "	"	16	6 00 a m	30.12	44.0	48.0	42.5	S.W.	?	S. & C. S.	10	"	cc, b	
3½ miles above Kitsalas Canon ..	"	16	6 00 p m	29.98	55.5	.....	.....	We'srly	2	S. & C. K.	8	"	o........	
3½ " " " ..	"	17	6 00 a m	30.055	48.0	.....	47.0	S.W.	2	S.	10	"	o, p, westerly wind ?.....	
14 " " " ..	"	17	6 00 p m	29.93	54.5	.....	.....	?	2	S. & C. S.	9	"	o, p	
14 " " " ..	"	18	6 00 a m	29.945	48.5	.....	48.0	S.W.	2?	S. & C. S.	8	"	cc, p, west wind, 3 to 4 ..	
2½ miles below Quatsalix	"	18	6 00 p m	29.850	58.5	.....	.....	S.S.W.	4	S. & C. S.	10	"	o, westerly wind	
2½ " "	"	19	5 00 a m	29.88	50.5	....	50.0	S.S.W.	3	S.	10	"	o, pp, westerly wind.....	
Op. Kit-wan-gah (40' above river)	"	19	6 30 p m	29.58	52.5	.....	.....	W.S.W.	2	S.	10	Rain	clearing	
" " " "	"	20	5 30 a m	29.62	44.5	....	41.0	ab.s.s.w	2	C.S.	3	Fair	6 cc, p, c, b........	
3½ miles above Kitsigeuola	"	20	6 30 p m	29.47	54.5	.....	.....	N.W.	1	C.K.	3	"	b, c, p........	6.30 p.m., upper} clouds from E.S.E.
3½ " "	"	21	6 00 a m	29.48	41.5	.....	41.0	N.N.E.	2	C.K.	2	"	....	
Skeena Forks.....	"	21	7 00 p m	29.42	59.0	.....	.....	E.	1	S. & C. K.	5	"	b, c, p.	
" "	"	22	6 00 a m	29.53	44.0	.....	37.5	E.	1	———	0	Fair, low fog	bb, c	
" "	"	22	7 00 p m	29.305	78.0		.....	S.	1	K. & C.K.	2	Fair	b, c, w, calm........	
" "	"	23	6 00 a m	29.40	49.5	.....	41.0	S'therly	1	K. & C. S.	7	"	b, cc, p........	
Watsonkwa River	"	23	6 00 p m	28.95	68.0	.....	.....	S.E.	3	C.S.	3	"	o, p	
" "	"	24	5 30 a m	29.02	50.5	.....	49.5	Wes'rly	3	S. & C. S.	10	Showery...	b, p. south-westerly wind	
Suskwa River	"	24	6 30 p m	28 66	61 5	.....	.....	W.	3	K.C.	4	Fair	o, pp	
" "	"	25	6 30 a m	28.70	48.5	.....	47.0	Wes'rly	2	S.	10	Rain......	bb, p, westerly wind.....	
Oo-ats-an-li River........	"	25	6 30 p m	27 27	58.0	.....	.....	W.N.W	4	C.K.	1	Fair	bb, c	
" "	"	26	5 30 a m	27.35	43.5	.....	30.5	W.N.W	3	S. & C. K.	8	"	b, p, cc, westerly wind...	
Summit Babine Portage........	"	26	6 30 p m	25.525	53.0	.....	.....	W.N.W	2	S. & C.S.	3	"	o, pp, t, S.W. wind	
" " "	"	27	6 00 a m	27.32	38.0	.....	36.0	S.W.	3	K.C.	4	"	cc, b, pp, S. W. wind	
Babine Lake	"	27	6 30 p m	27.45	42.0	.....	.....	S.W.	4	K. C. & S.	10	Showery...	o, r, westerly wind	
" "	"	28	6 00 a m	27.47	35.0	.....	35.0	W.	4-5	S.	10	"	o, clearing........	6 a.m., rain and sleet.
" "	"	28	6 00 p m	27.50	48.5	.....	.....	W.N.W	4	K.C.	9	Fair	o, pp, W.N.W. w.; squally	
" "	"	29	8 00 a m	27.525	44.5	49.0	38.5	W.N.W	4-5	S. & C. K.	9	Showery...	b, c, N.W. wind; clearing	
" "	"	29	6 00 p m	27.545	.....	.....	.....	N.W.	3	C.K.	4	" ...	b........	
" "	"	30	5 30 a m	27.65	33.5	.....	26.0	———	0	———	0	Fair	b, westerly wind	5.30 a.m., cloudless; heavy frost on grass.
Na-tal-kuz (H. B. post and Indian village, ¼ up Babine L.)......	"	30	6 00 p m	27.62	53.0	....	.....	W.	4	C.S.	1	"	b, light westerly wind ...	
" " " " "	July	1	5 15 a m	27.75	49.5	.....	37.0	W.	1	———	0	"	6b, clouding, westerly w. 4	
Babine Lake	"	1	6 30 p m	27.66	61.5	.....	.....	W.N.W	4	C.S.&C.K	9	"	b, c, westerly air........	
" "	"	2	4 30 a m	27.70	47.0	.....	43.5	Wes'rly	2	C. & C. S.	3	"	b, c, becoming o	
Near South Bend of Babine L...	"	2	7 00 p m	27.63	59.5	.....	.....	S.W.	3	S. & C. S.	10	"	o, pp	
" " " " " ...	"	3	5 30 a m	27.665	46.5	.....	45.5	Eas'rly.	2	K.C.	8	Clearing ..	cc, pp, thunder	
Portage bet. Babine and Stuart Ls	"	3	7 30 p m	27.43	57.0	.....	.....	Eas'rly.	2?	S. & K. C.	10	Fair	c, w........	
" " " " "	"	4	5 30 a m	27.415	47.0	.....	35.5	N.	1	C. S. & S.	8	"	c........	
North end of Stuart Lake	"	4	7 00 p m	27.525	69.0	.....	.....	N.E.	3	C.K.&C.S	7	"	e, w........	
" " "	"	5	4 00 a m	27.475	45.0	.....	44.0	———	0	C.K.	9	"	o, pp, S.E. wind to 5.....	
Near Ft. St. James (Stuart Lake)	"	5	8 00 p m	27.55	.....	.....	.....	N.W.	1-2	C.S&C.K.	8	"	cc, b, westerly wind	
Ft. St. James (25' above Stuart L.)	"	6	7 30 a m	27.62	58.0	.....	49.5	W.N.W	4	C.K&C.S.	6	"	b, strong W.S.W. wind ..	
" " " " "	"	6	6 30 p m	27.63	66.0	.....	.....	W.NW.	4	C.S.	1	"	b, c, light westerly wind.	
" " " " "	"	7	6 30 a m	27.72	56.0	67.0	48.0	W.NW.	5	C.S.	6	"	b, cc, p, strong W.N.W...	
" " " " "	"	7	6 30 p m	27.70	60.5	.....	.....	W.NW.	5	S. & C. K.	8	"	b, c, W.N.W. wind	
" " " " "	"	8	5 30 a m	27.725	.....	64.0	.....	E.	2	C.S.	3	"	b, c, o, 6p, b. c, westerly..	
8 miles east of Fort St. James ..	"	8	6 45 p m	27.31	61 5	.....	.....	W.	3	C.K&C.S.	5	"	b, c, calm........	

PLACE.	Date.	Hour.	Barometer.	Temperature of Air.	Maximum.	Minimum.	Direction of Wind.	Force of Wind.	Kind of Cloud.	Am't of Cloud.	Weather at Time.	Weather during Next Interval.	Remarks.
				°	°	°							
8 miles east of Fort St. James..	July 9	5 00 a m	27.33	40.0	....	38.0		0	C.S.	3	Fair	o, light westerly wind...	
Salmon River (15' above water)..	" 9	6 00 p m	27.22	59.5	.....	.....	S.W.	1	C.S.& K.	5	"	b, o, calm..............	
" " " " ..	" 10	5 30 a m	27.23	42.5	.....	39.0		0	S.	10	Rain.......	o, oc, p.....	
Swamp River (30' above water)..	" 10	6 00 p m	26 915	50.0	.....	.....	S.S.W.	2	S. & C.S.	6	Clearing ..	c, b, calm..	
" " " " ..	" 11	5 00 a m	26.92	37.5	.....	36.0	S.	2	C.	2	Fair	bb, c, south-westerly wind	
Carp Lake (30' above water).....	" 11	6 30 p m	26.85	*49.	.....	.....	S.W.	1	C.S.	3	"	b, o	*Therm. read at 7.30 a.m.
" " " "	" 12	5 30 a m	26.80	47.0	.....	37 5	N.W.	2	C.K.	9	"	o, c, clearing; light W...	
Iroquois Creek (about 45' above)	" 12	6 00 p m	26.97	60.0	.....	.....	W.	3	C.K&C.S.	8	"	c, light westerly wind....	
" " " " "	" 13	8 00 a m	27.17	61.5	.....	42.5	W.	3	C.S.& K.	5	"	c, light westerly wind....	
" " " " "	" 13	6 00 p m	27.22	57.0	.....	...	N.W.	3	C.K.	3	"	bb, c, calm.............	
" " " " "	" 14	5 15 a m	27.32	29.0	71.0	27.0		0	C.	1	"	b, o, becoming o, light air	5.15 a.m., skim of ice on exposed water.
Fort McLeod (15' above L. McL'd)	" 14	6 00 p m	27.74	66.5	.. .	.....		0	C.K.& S.	10	"	o, b, c, w, calm	
" " " " "	" 15	6 00 a m	27.77	57.0	.....	47.5	N.	4	C.K&C.S.	9	"	cc, 5r, t, southerly wind..	
" " " " "	" 15	6 30 p m	27.63	47.5	.....	.....		0	S.	10	Rain.......	rr, southerly wind........	
" " " " "	" 16	8 00 a m	27.68	46.5	.....	46.5	S.	3	S.	10	Showery...	o, p	
" " " " "	" 16	7 30 p m	27.40	52.0	.....	.....		0	S.& C.K.	9	Fair	o, r......................	
" " " " "	" 17	6 00 a m	27.80	45.0	59.0	45.0	S.	2	S.	10	Rain.......	o, rr.....................	
McLeod's L. River (10' above w'r)	" 17	8 30 p m	27.82	52.0	.. ..	.....		0	S.	10	Clearing ..	o, p........	
" " " " "	" 18	5 15 a m	27.84	47.5	.....	45.0		0	S.	10	Fine	o, c, b...................	
Parsnip River (130' above water).	" 18	8 00 p m	27.70	56.0	.....	.....	S.	1	S. & C.S.	2	"	c, b	
" " " " .	" 19	6 00 a m	27.75	43.5	.....	42.0		0	?	..	Hazy	co, light winds...........	
East side Parsnip R. (water level)	" 19	6 00 p m	27.72	66.5	.....	.....	W.	1	K.&C.K.	4	Fair	c, b	6 p.m., air smoky from burning woods.
" " " "	" 20	5 30 a m	27.78	42.0	.....	38.5	E.	1		0	"	cc, b, p.m. dropping rain.	5.30 a.m., temperature of river water, 49.2°.
Misinchinca Rivr (25' above w'tr)	" 20	7 30 p m	27.60	63.0	.....	.....		0	C.S.	3	"	c, b, calm................	
" " " " "	" 21	5 00 a m	27.67	44.5	.....	44.5		0		0	"	b, c, t, light shower	
Misinchinca River	" 21	7 00 p m	27.60	63 0	.....	.....	W.	?	C.	4	"	o, o	
" "	" 22	5 15 a m	27.72	51.5	.....	49.5	W.	?	S.& C.K.	10	"	bb, c, N.W. wind	
Crossing of Misinchinca (10' ab.R)	" 22	8 30 p m	27.80	61.5	.....	.....		0	C.S.	1	"	b..........................	8.30 p.m., river water 52.5°.
" " "	" 23	6 00 a m	27.845	43.5	.. ..	41.5	N.	1		0	"	b, c, t, dropping rain	
" " "	" 23	6 00 p m	27.75	64.5	.....	.....	N.	1	C.K&C.S.	3	"	cc, p, b..................	
" " "	" 24	4 30 a m	27.80	46.0	77.0	46.0		0	C.	1	"	b, c, N.N.E. light wind ..	
Misinchinca River (6' ab. water)	" 24	6 00 p m	27.71	70.0	. ...	.....	N.N.E.	1	C.K.	3	"	b, o....	
" " " " "	" 25	5 00 a m	27.80	48.0	.....	45.0		0		0	"	bb, c, t..........	
" " " " "	" 25	6 00 p m	27.66	64.5	.....	.....	N.W.	1	C. & K.	4	"	bb, c, w..................	
" " " " "	" 26	4 00 a m	27.665	46 5	72.0	.....		0	C.S.	1	"	bb, c, o	
Mo. of Atunatche C'k (w'tr level)	" 26	6 00 p m	27.48	69.5	.....	.....		0	S.	10	" clear'g	b, o, t	6 p.m., thin coating of cl'ds
" " " " "	" 27	4 30 a m	27.505	50 5	.....	46.5		0	K.C.	9	Showery.	b, cc, o, t, b	

Summit of Pine Pass	"	27	7 45 p m	27.065	60.0	....	....	W.S.W.	2	C.K.	1	Fair	bb, w, calm	
" " "	"	28	6 00 a m	27.105	35.0	....	34.0	——	0	C.S.	1	"	bb, c, w	6 a.m., water of str'm, 50°.
Pine River (15' above water lev'l)	"	28	6 30 p m	27.29	64.5	....	....	——	0	——	0	"	bb, o.	
" "	"	29	5 00 a m	27.37	41.5	....	41.0	S.S.W.	?	S. & C.S.	9	"	b, c, p, S.W. wind	
Pine River (water level)	"	29	6 00 p m	27.37	57.0	....	....	S.W.	*	K.	4	"	cc, p, S.W. wind	*Clouds flying fast.
" "	"	30	5 30 a m	27.53	43.5	....	41.5	S.W.	3	K.	6	"	cc, o	
Pine River, 10' above water level	"	30	6 00 p m	27.67	54.5	....	....	N.W.	2	C.K.	9	"	cc, o, r	6 p.m., water of river 45.5°.
" " "	"	31	7 00 a m	27.76	42.5	....	38.0	N.N.W.	1	C.K.	10	Clearing	cc, o	
" " "	"	31	7 00 p m	27.82	56.0	....	....	N.W.	2	C.K.	8	Fair	bb, c, w	
" " "	Aug.	1	4 30 a m	27.84	40.5	....	35.5	W.	4?	K.C.	6	"	b, c, strong west wind	
" " "	"	1	6 00 p m	27.87	60.0	....	....	W.	5	C.K. & K.	4	"	bb, west wind	
" " "	"	2	4 30 a m	27.89	41.0	....	41.0	W.	3	——	0	"	bb, c, strong west wind	
Bench 20' above Pine River	"	2	6 30 p m	27.87	64.0	....	....	W.	3	C.K.	1	"	bb	
" " "	"	3	4 45 a m	27.91	38.0	....	30.5	L't var.	2	C.	2	"	bb, strong west wind	
Pine River Valley	"	3	8 15 p m	27.95	59.5	....	....	W.	1	C.K.	1	"	bb, calm	
" "	"	4	5 00 a m	28.04	29.5	....	28.0	W.	1	C.S.	1	White frost	bb, o, p, c, t, rr	
" "	"	4	6 00 p m	28.075	55.0	....	....	N.W.	?	C.S.	4	Fair	bb	
" "	"	5	5 00 a m	28.170	30.5	....	30.5	——	0	——	0	"	bb	
Up. F'ks Pine R. (10' ab. w'r lev.)	"	5	7 00 p m	28.130	67.0	....	....	N.W.	1	C.	1	"	bb	
" " "	"	6	5 00 a m	28.175	44.5	....	37.0	N.W.	2	C.	1	"	bb, west wind	
20' above Pine R., at Canon	"	6	6 00 p m	28.080	82.0	....	....	——	0	——	0	"	bb, w	
" " "	"	7	3 30 a m	28.22	39.5	....	39.5	L't var.	0	——	0	"	bb, westerly wind	
L. F'ks Pine R. (25' ab. w'r level)	"	7	7 00 p m	28.115	59.5	81.0	....	S.	2?	C.K.	1	"	c, o, t, bb, w	
" " "	"	8	5 00 a m	28.32	38.0	....	37.0	S.E.	1	C.	1	"	bb, c, S.W. wind	
14 miles up Coal Creek (w'r level)	"	8	6 30 p m	27.81	59.0	....	....	S. W.	1	C. & C.K.	2	"	bb	
" " "	"	9	5 00 a m	27.915	37.0	....	37.0	S. W.	1	C.	2	"	bb	
Summit bet. Coal & Buffalo Cr'ks	"	9	6 00 p m	26.98	64.0	....	....	——	0	——	0	"	bb, calm	
" " "	"	10	4 30 a m	27.02	47.0	....	47.0	S. S. E.	L't	C.K.	1	"	bb	
Buffalo Cr'k (15' above wat. l'vel)	"	10	3 00 p m	27.70	70.0	....	....	——	0	C.S.	5	"	c, t	
" " "	"	11	4 15 a m	27.73	40.5	....	39.5	S.	2	C.K.	2	"	bb, c, west wind	
Ridge west of D'Echafaud River	"	11	8 00 p m	27.50	55.0	....	....	W.	1	C.S.	1	"	bb, light westerly wind	
" " "	"	12	4 30 a m	27.52	47.0	....	47.0	——	0	K.	2	"	bb, a hot day	
D'Echafaud River	"	12	6 00 p m	27.96	62.0	....	....	——	0	C.S.	1	"	bb, w, calm	
" "	"	13	5 00 a m	28.01	39.5	....	36.0	——	0	C.K.	3	"	b, p, o, r, bb	
Plateau E. of D'Echafaud River.	"	13	6 30 p m	27.76	64.5	....	....	S. W.	L't	C. & C.S.	3	"	bb	
" " "	"	14	5 00 a m	27.88	37.0	....	32.0	——	0	C.S.	1	"	bb	
Plateau 25 m. E. of D'Echafaud R	"	14	6 00 p m	27.53	72.5	....	....	——	0	——	0	"	bb, o	
" " "	"	15	4 00 a m	27.58	41.5	....	41.5	——	0	——	0	"	b, c	4.30 a.m., thin C.S. clouds.
Plateau S. W. of Dunvegan	"	15	6 30 p m	27.645	67.0	....	....	W.S.W.	L't	C. S.	5	"	b, c and o, t.	
" " "	"	16	5 00 a m	27.63	55.0	73.5	53.5	W.S.W.	3	C.K.	9	"	o, c, S.W. wind	
Dunvegan (30' above Peace R.)	"	16	6 30 p m	28.65	61.5	....	....	W.	1	C.K.	3	"	cc, o, p.	
" " "	"	17	6 00 a m	28.69	51.0	....	47.0	W.S.W.	2	C.K.	9	"	cc, b, c, strong S.W. wind.	
" " "	"	17	7 00 p m	28.53	61.0	....	....	S. W.	3	C.S.	3	"	o, p	
" " "	"	18	5 00 a m	28.52	50.5	75.0	48.5	——	0	C.K.	9	"	o, cc, b, strong westerly	
Plateau N. of Ka-toot Lake	"	18	6 00 p m	27.50	69.0	....	....	W.N.W	3	C. & C.S.	3	"	cc	
" " "	"	19	5 00 a m	27.53	51.5	....	46.0	W.S.W.	3	C.S. & S.	8	"	o, p, light S.W. wind	
Lower Flat of Grande Prairie	"	19	7 00 p m	27.50	55.0	....	....	——	0	S. & C.	4	"	p, o	
" " "	"	20	5 00 a m	27.615	43.0	....	38.5	W.	2	C.K. & S.	9	"	c, bb, strong west wind	
Bear River (30' above water)	"	20	6 00 p m	27.60	49.5	....	....	W.N.W	2	C.S.	1	"	bb	
" " "	"	21	5 00 a m	27.63	26.0	....	26.0	W.	2	C. & C.S.	5	"	cc, o, rr, easterly wind	

PLACE.	Date.	Hour.	Barometer.	Temperature of Air.	Maximum.	Minimum.	Direction of Wind.	Force of Wind.	Kind of Cloud.	Am't of Cloud.	Weather at Time.	Weather during Next Interval.	PLACE.
				°	°	°							
Prairie S. of Isle de Montagne..	Aug. 21	6 00 p m	27.40	49.0	....	....	E.	4	S.	10	Rain	o, r	
" " " "	" 22	5 00 a m	27.50	45.5	....	45.0	—	0	S.	10	Fair	o, r.	
North bank Wapiti Valley	" 22	6 00 p m	27.65	50.0	....	....	N.W.	3	C.K & S.	10	Drizzle	o, p, west wind	
" " "	" 23	5 00 a m	27.71	35.0	....	35.0	W.	2	K.C.	9	Clearing...	o, p	Water of Wapiti R., 55°.
W. bank Smoky R. Valley, above Wapiti R	" 23	6 00 p m	27.55	43.5	....	....	W.	1	S.	10	Showery...	o, p	
" " " "	" 24	6 00 a m	27.62	39.0	....	37.5	—	0	S.	9	Fair	o, cc, p, strong W. wind..	
10′ above Wapati R. at mouth Mountain Creek	" 24	7 30 p m	28.12	55.5	....	....	W.N.W	2	C.K.	3	"	c, bb	
" " " "	" 25	5 30 a m	28 28	33.0	....	33.0	Var.	L't	—	0	"	bb, c, bb	
Smoky River (water level)	" 25	6 00 p m	28.37	53.0	....	....	N.	1	C.K.	1	"	bb, c, w	Water of Smoky R. 54°.
" " "	" 26	6 00 a m	28.45	37.0	....	35.0	NN.E.*	1	C.K.	9	"	b, c, N.E. wind	*In valley.
" " "	" 26	6 00 p m	28.55	55.0	....	....	—	0	S. & C.K.	8	"	cc	
" " "	" 27	5 30 a m	28.54	41.0	....	40.0	S.E.	1	S. & C.S.	9	"	o	Bar. read at 6 a.m.
Near mouth of Smoky R. (w. lev.)	" 27	6 30 p m	28.60	54.5	....	....	—	0	S. & C.S.	10	"	cc	
" " " "	" 28	6 00 a m	28.535	48.5	....	47.5	—	0	C.K.	10	Mist	bb, c	
Peace River (water level)	" 28	8 00 p m	28.72	50.0	....	....	—	0	C.K.	1	"	bb, c	Water of Smoky R. 49.5°; of Peace R. 48°.
" " "	" 29	6 00 a m	28.93	46.0	....	37.5	W.	1	C.K. & S.	8	Fog	cc, o	
Lac des Femmes, plateau betw'n Smoky R. and Dunvegan	" 29	6 00 p m	27.83	61.0	....	....	—	0	S. & C.S.	9	Fair	c	
" " " "	" 30	4 00 a m	27.82	....	....	38.0	—	0	C.K&C.S.	8	"	......	
Dunvegan (20′ above River)	" 30	7 15 p m	28.78	58.5	....	....	W.	1	S. & C.K.	9	"	c. b, S.W. wind	
" " " "	" 31	8 00 a m	28.92	47.0	....	37.0	W.	1	S.	9	"	cc	
" " " "	" 31	6 00 p m	28.84	57.0	....	....	—	0	S.	10	"	o	
" " " "	Sept. 1	7 00 a m	28.91	42.5	67.5	37.5	W.	1	C.K&C.S.	8	Mist. ..	cc, t	
" " " "	" 1	6 30 p m	28.95	57.5	....	....	Var.	L't	C.K.	3	Fair	bb	
" " " "	" 2	6 30 a m	29.06	33.5	75.5	31.0	W.	2	Fog.	..	"	bb, westerly wind	
" " " "	" 2	6 30 p m	28.96	58.0	....	....	W.	2	C.S.	1	"	bb, c, o, S.W. wind	
" " " "	" 3	6 00 a m	28.98	42.0	70.0	34.5	W.	1	S. & C.S.	9	"	c, p, S.W. wind	
" " " "	" 3	6 00 p m	28.95	56.0	....	....	S. W.	3	C. & C.K.	3	"	c, b	
" " " "	" 4	6 45 a m	29.225	41.5	74.0	33.5	WS.W.	2	—	0	"	bb	
" " " "	" 4	6 00 p m	29.175	59.5	....	....	W.	1	—	0	"	bb	
" " " "	" 5	6 00 a m	29.19	30.0	....	26.5	—	0	—	0	Fog	bb	
Ghost R., on Plateau	" 5	6 00 p m	28.18	61.5	....	....	—	0	—	0	Fair	bb	
" " "	" 6	5 30 a m	28.11	23.0	....	23.0	—	0	—	0	"	bb, S.E. wind	
Plateau 1½ m. N. of Bad Heart C'k	" 6	6 00 p m	27.85	66.0	....	....	E.	2	C.	2	"	b, c	
" " " "	" 7	6 00 a m	27.80	43.0	....	38.5	Var.	1-2	S. & C.S.	9	"	b, cc, S.E. wind, light....	
Plateau at Klos-kun Stream.....	" 7	6 00 p m	27.60	60.0	....	....	S.W.	1	C. & S.	6	"	c, b	
" " " "	" 8	5 30 a m	27.50	32.5	....	31.0	S.W.	1-2	S. & C.K.	4	"	cc, p, t	

Mouth of Simonette R., on Smoky R., 10' above water	"	8	7 00 p m	27.92	54.0			S.	2	S. & C.K.	9	Fair	o, oo	
" "	"	9	5 45 a m	28.03	33.5		33.0	S.	1-2	C.K.	3	"	bb, o, S.W. wind	
Plateau N. of Simonette River	"	9	6 00 p m	27.605	52.0			W.	4	C.K.	6	"	o, oo	
" " " "	"	10	6 00 a m	27.71	44.0		39.0	S. W.	1	S. & C.K.	9	"	o, p, N. wind	
" " " "	"	10	6 00 p m	27.85	46.0			W.	2	C.K.	9	"	o, bb, oo, o, p.	
" " " "	"	11	5 35 a m	27.87	37.0		27.0	S. W.	1	C.K. & S.	9	"	c, b, co, p, b, strong W. w	
Plateau E. of Smoky R.	"	11	6 00 p m	27.88	50.0			W.S.W.	4	C.S.	1	Fair, w'd f'g	bb, south-westerly wind	
" " "	"	12	5 00 a m	27.99	35.0		85.0	S. W.	2	C. & C.K.	3	Fair	bb, c, westerly wind	
" " "	"	12	6 30 p m	27.65	51.0			——	0	S. & C.K.	10	"	b, c, o	
" " "	"	13	5 00 a m	27.45	42.5		41.5	S.	3	S.	10	"	oo	
Sturgeon Lake (10' above water)	"	13	6 00 p m	27.55	53.0			S. W.	4	S.	10	Drop'g r'n	c, b, strong wind	
" "	"	14	5 30 a m	27.77	39.5		39.5	W.	4	C.S.	2	Fair	bb, c, strong S.W. breeze.	
Cree Settlement (35' ab. St'g'n L)	"	14	7 00 p m	27.77	47.0			S. W.	5	S.	8	"	c, wind falling to calm	
" "	"	15	6 00 a m	27.71	43.0		39.0	W.	4	C.K.	2	Wind rising	b, oo, p, strong W. wind 6-7	
Near watershed between Sturgeon Lake & Little Smoky R.	"	15	6 00 p m	27.76	56.0			W.N.W	4	K.C.	8	" falling	c, bb	
" "	"	16	6 00 a m	27.92	33.5		33.5		0	C.	1	Fair	bb, c, o	
Plateau S. of Little Smoky R.	"	16	6 00 p m	27.96	47.5			W.N.W	*2	S.	10	Drop'g r'n	o, bb, calm	* Clouds flying fast.
" "	"	17	6 00 a m	28.13	24.0		24.0	N. W.	1	C.S.	2	Fair	bb, c, westerly wind	
70' below Plateau, near S. E. bank of Little Smoky R.	"	17	6 30 p m	27.915	40.0			——	0	C.	1	"	co, o	
" " "	"	18	5 30 a m	27.88	38.0		35.0	N. W.	1	C.K.	10	"	c, light westerly wind	
Plateau	"	18	6 00 p m	27.75	48.0			W.N.W	*1	C.K.	4	"	bb, calm	* Clouds from N.N.W.
"	"	19	6 00 a m	27.63	*27.5		20.0	S.	1	C. & C.S.	3	"	c, light westerly wind	* Ther. probably affected by neighbouring fires.
Near I-a-pe-oo Lake	"	19	6 00 p m	27.30	47.5			Var.	L't	C.S.	2	"	bb, light westerly wind	
" "	"	20	6 00 a m	27.37	24.5		24.5	W.	1	C.S.	1	"	bb, light variable wind	
On Plateau rising towards Athabasca R.	"	20	6 00 p m	27.01	47.0			——	0	——	0	"	bb, calm	
" " " "	"	21	6 00 a m	27.02	25.0		25.0	——	0	C.S.	3	"	b, c, clouds from N.W	
" " " "	"	21	6 00 p m	26.98	53.0			*——	0	C.K.	5	"	co, b, calm	*Clouds coming from N.
" " " "	"	22	6 00 a m	27.11	31.5	61.5	30.0	——	0	——	0	"	c, bb, light variable winds	
Plateau N. of Athabasca R.	"	22	6 00 p m	27.10	48.5			——	0	——	0	"	bb, calm	
" "	"	23	6 00 a m	27.03	27.5		25.5	——	0	——	0	"	bb, light variable winds	
Marsh Head River	"	23	6 30 p m	27.15	52.0			——	0	——	0	"	bb, calm	
" "	"	24	6 00 a m	27.15	21.5		20.5	N. W.	1	——	0	"	bb, light southerly wind	
Drift Pile Camp, 8' above river	"	24	7 00 p m	27.16	47.5			L't var.	1	——	0	"	bb, light variable	
" " " "	"	25	6 00 a m	27.27	33.0		32.5	——	0	C.	1	"	bb, light variable	
" " " "	"	25	6 00 p m	27.19	55.0			E.	1	C.S.	1	"	bb, c, light variable	
" " " "	"	26	6 00 a m	27.24	43.5	74.0	29.0	W.	2	C.K.	1	"	bb, c, light westerly wind	
" " " "	"	26	6 00 p m	27.02	61.5			S.	1	S. & C.K.	9	"	o, p	
" " " "	"	27	6 00 a m	26.975	45.5		42.0	S.	2	S. & C.K.	9	"	c, p, t, light S.W. wind	
" " " "	"	27	6 00 p m	26.88	45.0			S. W.	1	S. & C.K.	6	"	co, o, calm	
" " " "	"	28	6 00 a m	26.73	36.0		29.0	S. W.	1	S. & K.C.	10	"	o, p	
" " " "	"	28	6 00 p m	26.81	41.0			N. W.	1	S. & C.K.	8	"	c, b	
" " " "	"	29	6 00 a m	26.91	30.0		28.0	N. W.	2	K. & C.K.	3	"	co, o, p, h, str. westerly w	
" " " "	"	29	6 30 p m	26.96	44.5			S. W.	4	S.	10	"	o, light wind	
" " " "	"	30	6 00 a m	27.10	39.5		38.0	S. W.	2	S.	10	"	c, o, light easterly wind	
Athabasca R., (water level)	"	30	6 00 p m	27.17	43.0			——	0	S.	10	"	co, o, light wind	Water of river, 45.5°.

PLACE.	Date.	Hour.	Barometer.	Temperature of Air.	Maximum.	Minimum.	Direction of Wind.	Force of Wind.	Kind of Cloud.	Am't of Cloud.	Weather at Time.	Weather during Next Interval.	Remarks.
				°	°	°							
Athabasca River (water level) ..	Oct. 1	6 00 a m	27.20	35.0	.....	34.5	West'ly	1	S.	10	Fair	cc, c, p, wes'ly wind, sq'ly	
" " " "	" 1	6 00 p m	27.62	44.5	.....	.....	——	0	S.	3	"	cc, b, N.W. wind, squalls.	Water of river 45.5°.
" " " "	" 2	6 00 a m	27.75	29.0	.....	29.0	N.W.	1	——	0	"	c, becoming o, E'ly w. 1-2	
" "	" 2	6 00 p m	27.78	41.5	.....	....	Var.	1	S.& C.K.	8	"	o, bb, calm	Bar. 10' above water.
" "	" 3	6 00 a m	27.58	24.5	.....	24.5	——	0	——	0	"	bb, c, p. light N.W. wind.	" "
" "	" 3	6 00 p m	27.625	42.0	.....	.....	——	0	C.K.	2	"	b, c, bb	Bar. 12' above water.
" "	" 4	6 00 a m	27.675	29.0	.....	28.5	——	0	——	0	"	bb, c, light S.W. wind....	" "
" " (water level)..	" 4	6 00 p m	27.675	44.5	....	.....	——	0	C.S.	9	"	b, cc, o, l't wind, showers	
" " " "	" 5	6 00 a m	27.36	41.0	....	28.0	——	0	S.	10	Drop'g r'n.	o, p, cc, p, S.W. ch'g N.W.	
" "	" 5	6 00 p m	27.52	44.5	.....	.....	N.W.	2	K. & S.	8	Showers..	cc, b, c	Bar. 12' above water level.
" "	" 6	6 00 a m	27.765	27.0	.....	26.5	W.	1	S.& C.S.	8	Fair	cc, l't snow fl'rs. N.W.w'd	" " "
Slave Lake R. (water level)....	" 6	6 00 p m	27.92	34.0	.....	.....	N.N.W.	2	S.	3	"	c, bb, calm............	Water of Athabasca 45°; water of Slave Lake R.44°
" " " "	" 7	6 00 a m	28.06	25.0	.....	25.0	W.	1	S.	4	"	cc, o, N.W. w'd, sq., snow	
" " " "	" 7	6 00 p m	28.17	30.5	.....	.....	W.	1	S.	9	"	bb, calm............	
" " " "	" 8	6 00 a m	28.075	16or–	.....	16or–	——	0	——	0	"	bb, c, o, light var. winds.	
" "	" 8	6 00 p m	27.86	34.5	.....	.....	——	0	S.	10	"	o, p, c, b, calm	Bar. 10' above water level.
" "	" 9	6 00 a m	27.89	25.5	.....	25.5	——	0	C.S.	2	"	b, c, light westerly winds.	" " "
" "	" 9	6 30 p m	27.765	35.0	.....	...	——	0	C.K.	1	"	bb, cc, p of hail.........	Bar. 81' above water level, read at 7 p.m.
" "	" 10	6 00 a m	27.70	32.0	.....	27.0	W.	4–5	C.K. & S.	8	"	o, N.W. gale, snow in sq.	" " "
" " (water level).....	" 10	6 00 p m	27.83	28.0	.....	.....	N W.	7	S.& K.C.	10	"	cc, o, strong N.W. wind..	
" " " "	" 11	6 00 a m	28.07	26.0	.....	26.0	N.W.	5	S.	10	"	o, cc, strong N.W. wind in squalls with some snow, wind dying away.......	
" "	" 11	6 30 p m	28.195	27.5	.....	.....	N.N.W.	2	S.	9	"	cc, calm................	Bar. 10' above water level; water of river 38°.
" "	" 12	6 00 a m	28.20	21.0	.....	20.5	Var.	L't	S.	10	"	Snow and easterly wind, o	" " "
Athabasca R.	" 12	6 00 p m	28.03	25.0	.....	.....	E.	1	S.	10	Flakes of s.	cc, b	Bar. 10' above river.
" "	" 13	6 00 a m	27.85	26.0	.....	26.0	——	0	——	0	Fair	bb, c, easterly wind......	" "
" " (water level)......	" 13	6 00 p m	27.835	36.5	.....	.....	——	0	S.	7	"	c, cc, o, light snow......	Water of river 36°.
" " " "	" 14	6 00 a m	27.945	39.5	.....	36.0	Var.	1	S.	10	"	cc, o, easterly wind......	
Athabasca Landing, Athabasca R., (15' above R.)	" 14	6 30 p m	28.055	33.0	.....	.....	——	0	S.	10	"	cc, o	
" " " "	" 15	6 30 a m	28.12	32.0	.....	30.0	N.	1	S.	10	"	o, flakes of snow.........	
" " " "	" 15	6 00 p m	28.25	32.0	.....	.....	W.	2	C.K.	8	"	o, bb, calm or light wind.	
" " " "	" 16	6 00 a m	28.34	18.5	....	16.0	E.	1	C.S.	3	"	b, cc, easterly wind......	
Tow-ti-now Creek Valley	" 16	6 00 p m	27.875	26.0	.....	.....	——	0	S.& C.K.	4	"	b, bb, cc, o, calm	
" " "	" 17	6 00 a m	27.98	29.0	.....	8.5	——	0	S.	10	"	cc, b, c, calm	
Bridge Lakes	" 17	6 00 p m	27.855	33.0	.....	.....	——	0	S.	3	"	b, c	

Bridge Lakes	"	18	5 30 a m	27.83	26.5		24.5	—	0	S. & C.S.	5	Fair	b, c, S.W. wind, mild	
Sturgeon R. (15' above water)	"	18	6 00 p m	27.86	34.0			S. W.	1	S.	8	"	c, b	
" "	"	19	6 00 a m	27.70	33.5		25.0	Var.	1-2	S.	3	"	o, strong S.W. wind	
Camp at Rat Cr., E. of Edmonton	"	19	6 00 p m	27.625	48.5			W.	2	S.	5	"	o, p	
" " " "	"	20	6 30 a m	27.875	26.5		26.5	E.	3	S.	10	Snow	c, easterly wind	
Fort Edmonton (110' above river)	"	20												
" " " "	"	21	6.00 a m	27.87	28.0			N.W.	2	C.S & C.K.	8	Light snow	b, strong N.W. wind	Bar. read at 7 a.m.
" " " "	"	21	11 00 p m	28.10	30.0			N.W.	3	S.	3	Fair	bb	
" " " "	"	22	7 00 a m	28.23	26.0		23.5	—	0	—	0	"	bb, light westerly wind	
" " " "	"	22	6 00 p m	28.22	32.0			E.	1	—	0	"	bb, easterly wind	
" " " "	"	23	7 00 a m	28.01	33.5	44.0	25.5	E.	3	C.	1	"	b, c, strong southerly wind	
" " " "	"	23	6 00 p m	27.775	41.0			S.	2	C.S.	8	"	cc, o, b	
" " " "	"	24	7 00 a m	27.59	30.5	50.0	27.0	—	0	S.	8	"	c, p, southerly wind	
" " " "	"	24	6 00 p m	27.72	40.0			N.N.W	2	C.S.	2	"	c, b	
" " " "	"	25	7 00 a m	27.90	28.5	57.0	25.5	N.W.	3	S.	3	"	c, strong W. wind	
Camp bet. Edmonton & F. Sask'n	"	25	6 00 p m	27.91	40.5			N.N.W	2	C.K.	8	"	b, o, p	
" " " "	"	26	6 00 a m	27.93	35.0		27.5	S. W.	2	S.	10	Showery	cc, o, strong W. wind	
Fort Saskatchewan	"	26	6 30 p m	27.92	54.0			W.	5-6	S.	10	Fair	cc, c, strong W. wind	
" "	"	27	8 00 a m	28.11	39.5			W.	3	C.K.	6	"	cc, o, p, wind variable	
Near Beaver Hills	"	27	6 00 p m	27.80	42.0			N.N.E.	4	S.	10	Showery	c, b, st'g N.W. since 2 a.m.	
" " "	"	28	6 00 a m	27.74	35.5		31.5	N.W.	7	C.S.	4	Fair, w'd f'g	c, o, st'g N.W., pas'g snow	
Near Egg Lake	"	28	6 00 p m	28.00				N.N.W	4	S. & C.S.	8	Fl'rs of sn.	c, b, wind falling	
" " "	"	29	6 30 a m	28.28	20.0			N.W.	2	S.	9	Fair	c, b, p, snow, N.W. wind	
East of Egg Lake	"	29	6 00 p m	28.47	10.5			N.W.	2	C.K.	3	"	c, b, calm	
" " "	"	30	6 00 a m	28.53	2.5		-2.5	—	0	C.K. & S.	4	"	c, o, l't E. wind, pas'g sn.	
Chain of Lakes	"	30	6 00 p m	28.38	14.0			E.	1	C.K. & S.	10	Light snow	cc, o, light snow	
" "	"	31	6 00 a m	28.28	13.0		12.5	E.N.E.	2	S.	10	"	o, p, l't sn., l't E.N.E. w'd	
Vermilion River	"	31	7 00 p m	28.33	13.0			Var.	1	S.	10	Fair	o, light variable wind	
" "	Nov.	1	6 00 a m	28.37	7.0		6.0	N.E.	2	S.	10	"	o, c, light easterly wind	
Near Vermilion River	"	1	7 00 p m	28.05	8.0			S.E.	2	S.	10	"	cc, o, easterly 2-4	
" " "	"	2	6 30 a m	27.93	10.0		7.0	E.	3	C.K.	8	"	o, c, o, easterly wind	Clouds from the west.
North of Blackfoot Hills	"	2	6 00 p m	27.98	18.0			E.N.E.	2	C.K. & S.	10	"	o, c, easterly wind	Clouds from the west.
" " "	"	3	6 00 a m	27.88	16.0		9.0	N.E.	1	S.	8	"	c, cc, light easterly wind.	
Trail toward Battleford	"	3	6 00 p m	27.62	20.0			E.	2-3	S.	4	"	c, b, c, o	
" " "	"	4	6 00 a m	27.58	25.0		16.5	W.	3	S.	10	Snow	c, b, bb, westerly 2-4	
" " "	"	4	6 00 p m	27.97	27.0			W.	2	—	0	Fair	b, bb	
" " "	"	5	6 00 a m	27.88	15.0		14.5	E.	1	S. & C.K.	4	"	c, bb, l't E. w'd, calm p.m.	
Lake 8 miles west of Battleford	"	5	6 00 p m	27.93	21.0			—	0	—	0	"	bb, calm	
" " " "	"	6	5 30 a m	27.97	8.0		8.0	—	0	—	0	"	c, o	
Battleford	"	6	10 30 p m	27.97				—	0	—	0	"	bb, o	
"	"	7	9 00 a m	28.10						S.	10	Light snow	o, light snow, calm	
Trail bet. Battleford & Duck L.	"	7	6 00 p m	28.22	31.0			N.W.	3	S.	10	"	c, bb, calm	
" " " "	"	8	6 30 a m	28.21	2.5		-2.0	E.	1	—	0	Fair	bb, c, light S.E. wind	
" " " "	"	8	6 30 p m	28.03	16.0			—	0	—	0	"	c, bb	
" " " "	"	9	6 00 a m	28.09	5.0		4.0	E.	2	S.	1	"	b, cc, o, south-easterly	
" " " "	"	9	6 30 p m	28.30	20.0			S.E.	3	S.	10	"	o	
" " " "	"	10	5 30 a m	28.33	11.5		11.0	S.E.	2	S.	10	"	cc, bb, l't E. ch'g to l't W.	
" " " "	"	10	6 00 p m	28.025	12.0			E.	2	—	0	"	bb	
" " " "	"	11	5 30 a m	27.89	4.0		-2.0	E.	3	—	0	"	b, cc, c, easterly wind	
" " " "	"	11	6 00 p m	27.83	14.0			E.	1	C.S.	3	"	cc, o, sn., 3 inches snow.	

PLACE.	Date.	Hour.	Barometer.	Temperature of Air.	Maximum.	Minimum.	Direction of Wind.	Force of Wind.	Kind of Cloud.	Am't of Cloud.	Weather at Time.	Weather during Next Interval.	Remarks.
Trail bet. Battleford & Duck L.	Nov. 12	6 00 a m	27.80	20.0	.....	9.0	N.N.E.	3	S.	10	Fair	light snow, o.	
Duck Lake	" 12								S.	10	"	o.	
"	" 13	6 30 a m	27.96	9.0	.....	8.0	W.	2	S.	10	"	o, c, b, l't westerly wind.	
Trail 11 m. E. of S. Saskatchewan	" 13	6 00 p m	28.08	-3.0	.....	.....	S.S.E.	2	S.	2	"	b, o.	
" " "	" 14	6 00 a m	27.90	11.0	.....	-4.0	N.N.E.	3	S.	8	"	cc, c, N.E. wind	
Trail E. of S. Saskatchewan	" 14	6 00 p m	27.83	6.0	.....	.....	N.N.W	2-3	S. & C.K.	9	"	o.	
" " "	" 15	6 00 a m	27.93	3.0	.....	2.0	E.	2	S.	10	"	o, cc, l't E. w'd, flakes sn.	
Near Humboldt	" 15	6 00 p m	28.01	6.0	.....	.....	——	0	S.	3	"	o, light snow	
" "	" 16	6 00 a m	28.23	10.0	.....	-0.5	N.W.	2	S.?	10	"	o, cc, b, light westerly	
Trail S. E. of Humboldt	" 16	6 00 p m	28.54	-4.0	.....	.....	N.N.W	1	——	0	"	bb, o.	
" " "	" 17	6 00 a m	28.73	6.0	.....	-9.0	S. W.	1	S.	10	"	o, light S. wind, mist	
Touchwood Hills	" 17	9 00 p m	28.33	14.0	.....	.....	S. W.	3	S.	10	"	o, S.W. wind	
" "	" 18	6 30 a m	27.95	23.0	.....	10.0	S.	4	S. & C.K.	10	"	o, cc, b, S. turn'g to W	
Touchwood Hills Post	" 18	6 30 p m	27.71	29.0	.....	.....	W.N.W	4	C. K.	1	"	c, bb	
" "	" 19	7 30 a m	28.475	-5.0	.....	-6.0	N.N.F.	2-6	——	0	"	bb, light N.N.E. wind	
" "	" 19	6 00 p m	28.460	-13.	.....	.....	——	0	C. S.	2	"	bb, o.	
" "	" 20	6 00 a m	28.04	9.0	.....	-14.0	S.E.	3	S. & C.K.	10	"	cc, c, cc, S. turning to W.	
Trail S. E. of Touchwood Hills	" 20	6 30 p m	27.78	18.0	.....	.....	N.W.	3	C. K.	5	"	bb, c.	
" " " "	" 21	6 00 a m	27.80	19.0	.....	10.0	S. W.	2	C. S.	3	"	cc, c, W. & N.W. w'd, l't.	
" " " "	" 21	6 00 p m	27.73	28.0	.....	.....	N. W.	3	S. & C.K.	4	"	c, b, strong N.W. wind	
" " " "	" 22	5 30 a m	27.80	22.5	.....	22.5	N.W.f'g	3	C. K.	3	"	bb, strong W. wind	
" " " "	" 22	6 00 p m	28.23	5.5	.....	.....	N.W.	2	——	0	"	bb, N.W. wind; light.	
" " " "	" 23	6 00 a m	28.315	-7.0	.....	-9.5	N. W.	2	——	0	"	bb, c, cc, o, N.W. to calm, S.E.	
Near Cut Arm Creek	" 23	6 00 p m	28.07	24.0	.....	.....	S.	3	S.	10	"	o, strong W. to N.W. wind	
" "	" 24	6 00 a m	28.07	18.0	.....	18.0	W.N.W	4	C.K. & S.	10	"	o, cc, b, N.W. 5-6, snow.	
Qu'Appelle Valley	" 24	6 00 p m	28.61	17.0	.....	.....	N.W.	3	C. K.	9	"	c, b, squalls	
" "	" 25	5 30 a m	28.66	0.5	.....	0.0	——	0	C. S.	4	"	b, c	
Fort Ellice	" 25	6 00 p m	28.59	17.0	.....	.....	N.N.E.	1	C. K.	9	"	b, c, o.	
"	" 26	6 30 a m	28.75	11.0	.....	9.0	N.W.	2	S.	10	"	cc, c, calm	
Camp E. of Bird Tail Creek	" 26	6 30 p m	28.40	8.0	.....	.....	N.W.	3	C. K.	10	"	c. cc	
" " " "	" 27	6 00 a m	28.35	6.0	.....	-3.0	S. W.	1	C. K.	9	"	c, b, light to calm	
Camp E. of Shoal Lake	" 27	6 00 p m	28.82	12.0	.....	.....	L't var.	1	C. S.	6	"	b, c	
" "	" 28	4 30 a m	28.20	3.0	.....	-6.0	S.S.E.	1	C. S.	6	"	.....	

APPENDIX III.

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NOTE ON THE LATITUDES AND LONGITUDES

USED IN PREPARING

A MAP OF THE REGION FROM THE PACIFIC COAST TO EDMONTON.

OBSERVATIONS BY G. M. DAWSON, 1879.

In the case of observations of the sun, the angle given is the greatest double altitude, *ie.* twice the apparent altitude with the diameter of the sun. With stars the angle noted is also the double-altitude. The index error is in all cases allowed for.

Indian Village at upper end of Kitsalas Canon, Skeena River, June 16.

Sun at noon.. 118° 2′ 50″

Resulting latitude.................................... 54° 37′ 6″

North end Babine Lake, opposite Hudson Bay Post, June 29.

Time by watch........... 5h. 26m. 26s. Sun........... 48° 36′ 35″

" " " .... 5h. 29m. 10s. " .... 47° 40′ 50″

" " " .... 5h. 31m. 47s. " .... 47° 5′ 20″

Resulting error of watch.................................. 33s. slow

Observations on sun near meridian for latitude.

Time by watch........... 0h. 12m. 40s. Sun.. ....116° 16′ 35″

" " " .... 0h. 15m. 30s. " ....116° 11′ 50″

Resulting latitude.................................... 55° 20′ 0″

Moon on meridian, double altitude........................ 24° 37′ 10″

Resulting latitude.................................... 55° 22′ 19″

(Mr. Horetzky's latitude observed at the Hudson Bay Company's Post is probably more accurate than either of these.)

Babine Lake, July 1.

Sun at noon ....117° 0′ 16″

Resulting latitude.................................... 54° 52′ 39″

Babine Lake, July 2.

Sun at noon ....117° 26′ 16″

Resulting latitude.................................... 54° 35′ 29″

South end of Portage between Babine and Stuart Lakes, July 4.

Sun at noon..117° 4′ 46″
Resulting latitude.................................54° 36′ 22″

Stuart Lake, 200 yards south of Fort St. James, July 6.

Sun at noon..117° 1′ 6″
Resulting latitude.................................54° 26′ 51″

Same place, July 7,—

Sun at noon..116° 48′ 26″
Resulting latitude.................................54° 26′ 53″

Time by watch....... 3h. 36m. 15s. Sun................ 78° 36′ 6″
" " " .... 3h. 40m. 17s. " .... 77° 28′ 56″
" " " .... 3h. 47m. 34s. " .... 75° 25′ 56″
Error of watch from mean of observations..................3m. 30s. slow

Point where Fort St. James and McLeod's Lake trail first reaches Salmon River July 9.

Time by watch.......10h. 21m. 14s. Polaris............198° 4′ 56″
" " " ....10h. 28m. 44s. " ....108° 10′ 16″
Resulting latitude from mean of observations................ 54° 36′ 26″

Fort McLeod, July 15.

Sun at noon..113° 33′ 41″
Resulting latitude.................................55° 0′ 2″
Latitude by Mr. MacLeod's observation.....................55° 0′ 9″

Crossing of Misinchinca River, July 23.

Sun at noon..110° 9′ 10″
Resulting latitude.................................55° 14′ 39″

Summit Camp, Pine River Pass, July 28.

(Observation on η. Ursa Majoris for time.)

Time by watch.......... 12h. 35m. 53s. Star........... 60° 25′ 10″
" " " .... 12h. 40m. 42s. " .... 59° 27′ 40″
Error of watch by mean of observations.................. 5m. 57s. slow

Time by watch .... 12h. 9m. 10s. Polaris.........111° 43′ 40″
" " " .... 12h. 15m. 20s. " ....111° 46′ 50″
Resulting latitude by mean of observations.................. 55° 23′ 55″

Pine River, July 31.

Time by watch ....11h. 21m. 15s. Polaris ....111° 37′ 0″
" " " ....11h. 27m. 25s. " ....111° 41′ 0″
Resulting latitude by mean of observations.................. 55° 31′ 38″

Pine River, August 1.

Time by watch .... 5h. 17m. 20s, Sun.............. 42° 6′ 10″
" " " .... 5h. 20m. 49s. " .... 41° 8′ 10″
Error of watch by mean of observations..................... 6m. 3s. slow

Camp near Middle Forks of Pine River, August 5.

Altair on meridian.................................85° 53′ 45″
Resulting latitude.................................55° 37′ 20″

Time by watch......... 9h. 47m. 41s. Polaris...........110° 59′ 10″
" " " .... 9h. 55m. 10s. " ....111° 4′ 5″

Lower Forks of Pine River, August 7. (Hunter's Tree.)

Sun on meridian..110° 50′ 58″
Resulting latitude....................................55° 43′ 42″

Plateau east of Mud River, August 11.

Altair on meridian....................................85° 34′ 40″
Resulting latitude....................................55° 46′ 54″
Time by watch........10h. 33m. 3s. Polaris...........112° 9′ 0″
" " "........10h. 39m. 22s. "...........112° 13′ 50″

Plateau east of D'Echafaud River, August 13.

θ Aquilæ on meridian....................................65° 56′ 10″
Resulting latitude....................................55° 53′ 34″

Plateau east of D'Echafaud River, August 14.

Altair on meridian....................................85° 28′ 40″
Resulting latitude....................................55° 49′ 54″

Dunvegan, August 17.

Sun at noon....................................95° 25′ 0″
Resulting latitude....................................55° 56′ 11″

September 3.

Time by watch........... 8h. 49m. 47s. Polaris........112° 26′ 27″
" " "........... 8h. 57m. 55s. "........112° 31′ 37″

September 4.

(150 feet N. of former and succeeding observations.)

Sun at noon....................................82° 55′ 7″
Thermometer, 68° Barometer, about 29·20
Resulting latitude....................................55° 56′ 10″

September 4.

Observations on sun for time.

Time by watch......... 2h. 37m. 3s. Sun............. 57° 55′ 27″
" " "......... 2h. 38m. 39s. "............. 57° 32′ 37″
" " "......... 2h. 39m. 38s. "............. 57° 18′ 57″
" " "......... 2h. 41m. 46s. "............. 56° 48′ 37″

Thermometer 70° Barometer, 29·20

Resulting error of watch from mean of observations....... 30m. 59s. slow

September 4.

Time by watch......... 8h. 36m. 56s. Polaris...........112° 20′ 17″
" " "......... 8h. 40m. 27s. "...........112° 23′ 7″
" " "......... 8h. 45m. 44s. "...........112° 26′ 27″
Resulting latitude....................................———

September 4.

Altair on meridian....................................85° 16′ 7″
Thermometer, 38·5° Barometer, 29·20
Resulting latitude....................................55° 56′ 14″
Mean latitude adopted for Dunvegan (New Fort)............. 55° 56′ 11·5″

Grande Prairie, August 19.

Altair on meridian	86° 27′ 40″
Resulting latitude	55° 20′ 28″

Near Smoky River, August 24.

Sun at noon	92° 52′ 20″
Resulting latitude	54° 53′ 4″

Wapiti River, August 25.

Sun at noon	91° 39′ 20″
Resulting latitude	55° 9′ 2″

Smoky River Crossing, August 26.

Sun at noon	90° 18′ 40″
Resulting latitude	55° 28′ 30″

N. B.—Passing clouds, but probably good to within half a mile.

Smoky River, August 28.

Sun at noon	87° 57′ 35″
Resulting latitude	55° 57′ 3″

Smoky River Post, August 29.

Sun at noon	86° 45′ 45″
Resulting latitude	56° 11′ 39″

North Bank of Bad Heart River, September 6.

Time by watch	8h. 21m. 39s.	Polaris	111° 32′ 37″
" " "	8h. 25m. 56s.	"	111° 35′ 37″
Resulting latitude from mean of observations			55° 32′ 58″

N. B.—Watch 30m. 59s. slow, from observation at Dunvegan, September 4.

Plateau East of Smoky River, September 11.

Altair on meridian	86° 26′ 40″
Resulting latitude	55° 20′ 56″

Cree Settlement, Sturgeon Lake, September 14.

Sun at noon	77° 4′ 45″
Resulting latitude	55° 4′ 50″

Little Smoky River, September 18.

Altair on meridian	88° 14′ 25″
Resulting latitude	54° 27′ 4″

Sources of I-a-pe-oo River.

Altair on meridian	88° 36′ 35″
Resulting latitude	54° 15′ 59″

Drift-pile Camp, Athabasca River, September 24.

Altair on meridian	88° 53′ 25″
Resulting latitude	54° 7′ 33″

September 25.

Sun at noon		70° 26′ 39″
Thermometer, 70°	Barometer 27·20	
Resulting latitude		54° 7′ 50″

Observations for time by equal altitudes of sun.

A.M.	Time by watch.........	8h. 28m. 1s.	Sun..............	53° 35′ 39″
	" " "	8h. 33m. 33s.	"	54° 41′ 59″
	" " "	8h. 42m. 35s.	"	56° 26′ 49″
P.M.	Time by watch.........	1h. 19m. 30s.	Sun..............	56° 26′ 49″
	" " "	1h. 28m. 33s.	"	54. 41′ 59″
	" " "	1h. 34m. 7s.	"	53° 35′ 39″

Error of watch by mean of observations, 50m. 14s. slow.

Observations on Altair for latitude.

Time by watch.........	6h. 33m. 37s.	Star..............	88° 52′ 59″
" " "	6h. 36m. 27s.	"	88° 53′ 24″
" " "	6h. 39m. 55s.	"	88° 52′ 19″
" " "	6h. 43m. 19s.	"	88° 50′ 14″
" " "	6h. 45m. 19s.	"	88° 48′ 24″
Resulting latitude by highest angle read......................			54° 7′ 29″
Resulting latitude by probable angle deduced by plotting curve.			54° 7′ 31″
Time by watch.........	6h. 53m. 16s.	Polaris............	108° 44′ 54″
" " "	6h. 55m. 31s.	"	108° 44′ 49″
" " "	6h. 57m. 51s.	"	108° 47′ 4″
" " "	7h. 3m. 12s.	"	108° 51′ 34″
Resulting latitude by mean of observations.................			54° 7′ 22″
Mean latitude adopted for Drift-pile Camp..................			54° 7′ 34″

September 29.

Observation on sun for time.

Time by watch.........	9h. 32m. 44s.	Sun	53° 0′ 29″
" " "	9h. 34m. 17s.	"	53° 17′ 19″
" " "	9h. 36m. 20s.	"	53° 41′ 19″
" " "	9h. 38m. 7s.	"	54° 1′ 4″
Resulting error of watch...................... ———			

"Coal Crop," Athabasca River, October 1.

Sun at noon..................................	65° 49′ 20″
Resulting latitude................................	54° 11′ 40″

Athabasca River, October 2.

Sun at noon..................................	64° 50′ 25″
Resulting latitude................................	54° 12′ 45″

Athabasca River, near Fort Assineboine, October 3.

Sun at noon..................................	63° 51′ 55″
Resulting latitude................................	54° 18′ 54″

Athabasca River, October 4.

Sun at noon..................................	62° 48′ 35″
Resulting latitude................................	54° 26′ 54″

Mouth of Lesser Slave River, October 6.

Sun at noon..................................	59° 50′ 30″
Resulting latitude................................	55° 10′ 25″

Lesser Slave River, at Muskeg River, October 9.

Sun at noon			57° 16′ 40″
Resulting latitude			55° 18′ 14″

Athabasca River, October 13.

Sun at noon			54° 29′ 10″
Resulting latitude			55° 11′ 45″

Athabasca Landing October 15.

Time by watch	7h. 7m. 30s.	Polaris	110° 36′ 10″
" " "	7h. 22m. 0s.	"	110° 39′ 0″
" " "	7h. 24m. 0s.	"	110° 40′ 20″
" " "	7h. 26m. 40s.	"	110° 41′ 55″
Resulting latitude by mean of three last observations			54° 43′ 34″

Observation on Altair for time.

Time by watch	7h. 35m. 10s.	Star	80° 24′ 0″
" " "	7h. 39m. 30s.	"	79° 42′ 0″
Resulting error of watch			5m. 5s. slow

Observation on Jupiter for latitude.

Jupiter on meridian			47° 22′ 10″
Resulting latitude			54° 43′ 31″

Bridge Lakes, October 17.

Observation on Altair, near meridian for latitude.

Time by watch	5h. 59m. 30s.	Altair	88° 43′ 0″
" " "	7h. 8m. 50s.	"	83° 43′ 50″
Resulting latitude			———

Observation on Polaris for latitude.

Time by watch	7h. 17m. 30s.	Star	109° 36′ 20″
" " "	7h. 22m. 30s.	"	109° 40′ 30″
Resulting latitude by mean of observations.—			
First approximation			54° 9′ 47″
Second approximation			54° 9′ 58″

Observation on Vega for time.

Time by watch	7h. 28m. 20s.	Star	115° 31′ 50″
" " "	7h. 30m. 25s.	"	114° 45′ 30″
" " "	7h. 33m. 0s.	"	114° 8′ 25″
Error of watch by mean of observations			9m. 17s. slow

Sturgeon River, October 18.

Observation on Polaris for latitude.

Time by watch	7h. 10m. 0s.	Polaris	108° 57′ 0″
" " "	7h. 14m. 20s.	"	108° 59′ 40″
" " "	7h. 21m. 30s.	"	109° 4′ 10″
Resulting latitude by mean of observations			53° 50′ 12″

OBSERVATIONS FOR LONGITUDE.

Dunvegan. (Moon on Meridian.)

Latitude .... 55° 56′ 11″.5

Date, September 2, 14h. local mean time.

Observed double altitude, upper limb..85° 4′ 10″ Index error.. – 3′ 43″

Barometer, 28·95 Thermometer, 35°

Resulting declination of moon .... 8° 50′ 52″·5 (North)

Resulting longitude of Dunvegan .... 7h. 56m. 6s.5 = 119° 1′ 37″

Sir H. Lefroy's longitude for Dunvegan, by two sets of lunar distances, is 118° 25′ That given by comparison of track surveys east and west is nearly intermediate between this and that above determined, and has been adopted on the map.

Drift-Pile Camp. (Moon on Meridian.)

Latitude.................................... 54° 7′ 34″

Date, September 25, 8h. 45m., local mean time.

Observed altitude, lower limb....39° 43′ 10″ Index error.... – 3′ 11″

Barometer, 27·20 Thermometer, 40°

Resulting declination of moon...................... 14° 55′ 59″ (South)

Resulting longitude of Camp......................... 7h. 47m. 13s.9 = 116° 48′ 30″

Same place, September 27.

Observation of re-appearance of Jupiter's satellite (I) for longitude:

Corrected local time at place.......................... 10h. 0m. 29s.

Resulting longitude ....116° 27′ 30″

The position in longitude of Drift-Pile Camp has been determined by Mr. MacLeod's corrected track survey to the instrumentally measured line of the Canadian Pacific Railway, near Dirt Lake. It agrees very closely with the first of the observations above given.

Limits of Error in Observations for Longitude by Moon on Meridian.

The change in the moon's declination hourly, is as follows, at the times in question:

Dunvegan.. 12′ 40″·3

Drift-Pile Camp.................................. 11′ 50″·4

Assuming the error of latitude to amount to 5″, the error in time may be 25s. in either case; corresponding to a total limit of 6′ 15″ in the value of longitude, or a ± error of 3′ 7″

LATITUDES DETERMINED BY C. HORETZKY, CANADIAN PACIFIC RAILWAY SURVEY, 1879.

Camp 5¼ miles from upper end of Bear Lake, July 15	55° 59′ 38″
On Driftwood (Tacla) River, July 17	55° 45′ 50″
On Tacla Lake, July 18	55° 33′ 37″
Lakelet on Trail to Fire-Pan Pass, July 20	55° 18′ 23″
Camp near Hudson Bay Post, north end Babine Lake, July 21	55° 16′ 53″
August 14	55° 18′ 7″
August 18	55° 18′ 2″
August 25	55° 18′ 34″
Mean	55° 17′ 55″
Variation, 28° E.	
Forks of Skeena, July 25	55° 13′ 55″
July 26	55° 14′ 47″
July 28, sun at noon, double alt., lower limb 106° 55′ 30″. (Not worked.)	
Variation, 28° E.	
Neelkitkwa River, Station 54, August 27	55° 30′ 9″
Variation, 28° E.	
Neelkitkwa River, Station 85, August 28	55° 33′ 36″
Neelkitkwa River, Station 127, August 30	55° 39′ 20″
Half a mile south of summit of Mount Horetzky, August 21	55° 37′ 12″
Five hundred feet south of summit of Mount Horetzky, August 31	55° 38′ 3″
Neelkitkwa River, Station 155, September 1	55° 42′ 3″
Camp near summit of Kotsine Pass, September 3	55° 45′ 44″
Variation, 28° E.	
Point slightly south (mag.) from Kotsine River, and about five miles from summit of Pass, September 4	55° 47′ 7″
At crossing of Kotsine-Sitlika, September 5	55° 46′ 37″
Driftwood River, near mouth, September 6	55° 42′ 15″
Tacla Landing, Station 1, Setpember 7	55° 36′ 18″
Lake Tacla, Station 12, September 8	55° 40′ 2″
Buckley House, September 10	55° 41′ 11″
Summit Camp, Fall River, September 13 (doubtful)	55° 38′ 20″
"Old Hogem," September 15	55° 45′ 33″
Variation, 27° E.	
Germansen Town, September 19	55° 44′ 38″
On Omenica River, September 20	55° 48′ 49″
On Omenica River, Station 64	55° 47′ 26″
On Omenica River, Station 103	55° 45′ 18″
Fall River Valley, September 23	55° 44′ 27″
Tacla Landing, Station 1, September 25	55° 35′ 40″
On Middle River, Station 76, September 30	54° 59′ 37″
On Trembleur Lake, October 1	54° 51′ 51″
Variation, 29° E.	

N.B.—From this point of observation Pope's Cradle, Stuart Lake bears S. 77° E. (mag.)

LATITUDES DETERMINED BY A. WEBSTER, OF THE GEOLOGICAL SURVEY OF CANADA, IN BRITISH COLUMBIA AND THE NORTH-WEST TERRITORY, 1875.

Quesnel-Blackwater Trail, east of Herkyelthtie Lake, July 7	53° 6′ 2″
Blackwater, Lower Canon, June 10	53° 17′ 6″
Telegraph Trail, north of Blackwater River, June 12	53° 33′ 16″
Telegraph Trail, north of Eulatazela Lake, June 14	53° 49′ 17″
Camp at Nechacco Crossing, June 16	54° 1′ 27″
Trail south-east of Stuart Lake, June 19	54° 23′ 23″
Fort St. James, June 21	54° 26′ 44″
Camp near outlet of Long Lake, June 27	54° 56′ 40″
Fort McLeod, June 30	55° 0′ 7″
Parsnip River, July 7	55° 22′ 14″
Parsnip River, July 8	55° 40′ 24″
Junction of Finlay and Parsnip Rivers, July 9	55° 59′ 36″
Peace River, July 10	56° 2′ 35″
Peace River, July 13	55° 58′ 33″
Peace River, July 15	56° 6′ 22″
Peace River, July 17	56° 2′ 7″
Hudson's Hope, July 23	56° 2′ 14″
Fort St. John, July 30	56° 6′ 59″
Pine River, August 1	56° 4′ 26″
Pine River (Indian Camp), August 3	55° 46′ 20″
Dunvegan, August 13	55° 55′ 53″
On Smoky River, August 20	55° 55′ 47″
Smoky River Post, August 22	56° 10′ 46″
Kerry's Lake (much vibration), October 3	54° 40′ 26″
Crooked River, October 5	54° 23′ 4″
Fort George, October 10	53° 54′ 29″

NOTE ON THE DISTRIBUTION OF SOME OF THE MORE IMPORTANT TREES OF BRITISH COLUMBIA.*

BY GEORGE M. DAWSON, D.S., A.R.S.M., F.G.S.

The following notes and map are presented as a contribution towards our knowledge of the range of some of the trees of British Columbia, based on notes and observations made by myself while engaged in the work of the Geological Survey from 1875 to 1879. I am indebted to Mr. H. J. Cambie of the Canadian Pacific Railway for notes on the extension of certain trees from the coast up the valleys of the Homathco and Dean or Salmon Rivers. In a few cases I have availed myself of facts published in Prof. Macoun's reports, and I am also indebted to Prof. Macoun for valuable notes on the first edition of this article. I have also to thank Dr. Engelmann for information furnished in regard to the specific relations of specimens collected in various parts of the province.

Since the publication of the first edition of these notes in the *Canadian Naturalist*, Prof. C. S. Sargent, Dr. Engelmann and Prof. Parry, have together visited a portion of the southern part of British Columbia, for the purpose of extending their observations on the distribution of forest trees. I am indebted to Prof. Sargent for several additional facts now incorporated in these pages. The lines on the map have also been slightly modified in some respects since the publication of the first edition.

Dependence of distribution on topography.

British Columbia forming a portion of the Cordillera region of the west coast of America, with diversified and bold physical features, the lines indicating the geographical range of the various species of plants do not assume in it the broad rounded forms found in less mountainous districts. The peculiarities in distribution, while adding interest to the study, renders an intimate knowledge of the topography of the country an essential prerequisite to its prosecution. As large tracts of the province are as yet geographically unknown owing to their remoteness and singular impenetrability, we are far from possessing complete information on the distribution of many of even the more important species.

It is not intended to give a description of the orography of the province, though as above indicated this is closely connected with the extension of the various species of plants. The following general

* These notes were first printed in the Canadian Naturalist, Vol. IX., No. 9, but have since been corrected in some particulars and added to.

statement made by me in a note on agriculture and stock raising and extent of cultivable land in the province,* may, with little alteration, be repeated here, as outlining the conditions to be found within its area:—The flora of British Columbia as a whole may be broadly divided into four groups, indicating as many varieties of climate, which may be named as follows: the *West Coast*, the *Western Interior*, the *Canadian*, and the *Arctic*. The first, with an equable cilmate and heavy rainfall, is characterized by a correspondent luxuriance of vegetation, and especially of forest growth. This region is that west of the Coast Range, and is well marked by the peculiarity of its plants. In a few spots only—and these depending on the dryness of several of the summer months owing to local circumstances—does a scanty representation of the drought-loving flora of the Califoranian coast occur. The second is that of the southern part of the interior plateau of the province, and presents as its most striking feature a tendency to resemble in its flora the interior basin of Utah and Nevada to the south and the drier plains east of the Rocky Mountains. It may be said to extend northward to about the 51st parallel, while isolated patches of a somewhat similar flora occur on warm hill-sides and the northern banks of rivers to beyond the Blackwater. In the northern part of the interior of the province, just such an assemblage of plants is found as may be seen in many parts of eastern Canada, though mingled with unfamiliar stragglers. This flora appears to run completely across the continent north of the great plains, and characterizes a region with moderately heavy rainfall, summers not excessively warm, and cold winters. The arctic or alpine flora is that of the higher summits of the Coast, Selkirk, Rocky and other mountain ranges, where snow lies late in the summer. Here plants lurk which deploy on the low grounds only on the shores of Hudson Bay, the Icy Sea and Behring's Strait.

Botanical regions.

Arrangement.

In the following notes the Coniferæ are placed first, as having the greatest importance both from an economic point of view, and from the vast extent of country which they cover almost to the exclusion of other trees.

Douglas spruce

Pseudotsuga Douglasii, Lindl. Douglas spruce, Douglas fir, sometimes commercially named 'Oregon pine.'—This is the most important timber tree of British Columbia, and the only one of which the wood has yet become an article of export on a large scale. It is found in all parts of Vancouver Island with the exception of the exposed western coast, but does not occur in the Queen Charlotte Islands or coast archipelago to the north of Vancouver. On the mainland, near the 49th parallel, it extends from the sea to the Rocky Mountains, growing at a

* Canadian Pacific Railway Report, 1877. Appendix 8.

height of 6000 feet in a stunted form, and occurring on the eastern slopes of the Rocky Mountains on the 49th parallel, and also according to Prof. Macoun, about the mouth of Kananaskis and up the valley of Bow River. In the dry southern portion of the interior of British Columbia it is confined to the higher uplands between the various river valleys. Northward it comes down to the general level of the country. It does not extend into the mountainous and comparatively humid region of Cariboo, and is probably absent from the higher portions of the Selkirk and Gold Ranges generally. Its northern line is singularly irregular. It is found about Fort George, and north-eastward as far as McLeod's Lake, but does not occur on the Parsnip. It extends about half-way up Tacla Lake, and on Babine Lake to the bend or knee. A few specimens occur on the Skeena River. It is common about Fraser and François Lakes. It is found from the Fraser to the coast mountains on the line of the Chilcotin and its tributaries, and occurs on the Nazco and up the Blackwater to the mouth of the Iscultaesli, but is absent from an extensive tract of country bounded by the last-named localities to the south and east, and extending northward to François Lake. It occurs abundantly on the coast of the mainland as far north as the north end of Vancouver Island, but beyond that point is found only on the shores of the inlets at some distance from the sea. It is found on the upper part of Dean Inlet and on the Salmon River which runs into it, but about forty-five miles from the salt water becomes small and stunted, and as above stated, is not seen in that part of the interior lying to the eastward.

The extent of its range to the north-eastward, in the Rocky Mountain Range, though broadly indicated on the map, is still uncertain. Lumber.

The best grown specimens are found near the coast in proximity to the waters of the many bays and inlets which indent it. Here the tree frequently surpasses eight feet in diameter, at a considerable height above the ground, and reaches a height of from 200 to over 300 feet, forming prodigious and dark forests. The wood varies considerably in appearance and strength according to its locality of growth and other circumstances. It is admirably adapted for all ordinary purposes of construction, and of late has obtained favourable notice in ship-building, remaining sound in water for a long time. For spars and masts it is unsurpassed both as to strength, straightness and length. Masts for export are usually hewn to octagonal shape from 20 to 32 inches in diameter and 60 to 120 feet in length. On special orders they have been shipped as large as 42 inches in diameter by 120 feet long. Yards are generally hewn out from 12 to 24 inches in diameter and 50 to 120 feet long.

Masts and spars are generally sent to Great Britain; other forms

of lumber to South America, Australia, India, China and the Sandwich Islands.

Western hemlock.

Tsuga Mertensiana, Lindl. Western hemlock.—The hemlock occurs everywhere in the vicinity of the coast, and extends up the Fraser and other rivers to the limit of the region of abundant rainfall. It reappears in the Selkirk and Gold Ranges, where sufficient moisture for its growth is again found. The tree attains a large size on the coast, reaching a height of 200 feet, and yields a good wood, but has not yet been much used. The bark is employed successfully in tanning. *Tsuga Mertensiana* closely resembles the eastern hemlock (*T. Canadensis*) but attains a larger size than that tree ever does.

In the Queen Charlotte Islands it is particularly abundant and large. On the Salmon River, running into Dean Inlet, it is not found in abundance beyond eighteen miles from the sea, at an elevation of 600 feet. It occurs again, however, sparingly on the lower part of the Iltasyouco River, a tributary to the last within the Coast Range. On the Homathco River, flowing into Bute Inlet, it ceases at fifty-three miles from the sea at an elevation of 2320 feet. On the Uz-tli-hoos* it extends to a point six or ten miles east of the Fraser, on the Coquihalla to the summit between that river and the Coldwater. It is mentioned by Sir A. Mackenzie (Voyages, p. 223) as occurring at the headwaters of the Parsnip (about lat. 54° 30′). This is the most northern locality yet known.

Williamson's hemlock.

Tsuga Pattoniana, Engelm. (*Abies Williamsonii.*)—This tree has been found by Mr. Sargent on Silver Mountain between 4000 and 6000 feet elevation, and it is suggested may extend much further north, as it is essentially alpine in habit, and in the Sierra and Cascade Mountains almost always associated with *Pinus Albicaulis*.

Western cedar.

Thuja gigantea, Nutt.—Western arbor vitæ, Giant cedar, Red cedar.—This tree in its distribution nearly follows that of the hemlock, abounding along the coast and lower parts of the rivers of the Coast Range, being unknown in the dry central plateau, but reappearing abundantly on the slopes of the Selkirk and Gold Ranges. On the Salmon River the cedar ceases at forty-five miles from the head of Dean Inlet at an elevation of 2400 feet, though like the hemlock it is again found sparingly and in a stunted form in the lower part of the Iltasyouco valley. On the Homathco it ceases at a distance of sixty-three miles from the coast at an elevation of 2720 feet. On the Uz-tli-hoos it ends with the hemlock at about six miles east of Boston Bar; on the Coquihalla, just south of the summit between that river and the Coldwater. Cedars are also found sparingly on the Skaist River or east branch of the Skagit, and a few were observed on the banks of the Similkameen,

* North-east branch of the Anderson, followed by the trail from Boston Bar to Nicola.

about thirteen miles below Vermilion Forks. It extends westward from the flanks of the Gold Range in the Coldstream valley sparingly to within eight miles of the head of Okanagan Lake. It abounds round the shores of the north-eastern part of Shuswap Lake, and in the North Thompson valley to about twenty miles below the mouth of the Clearwater. It is said that there is also a grove of these trees on the Fraser below Fort George. It also grows in the Quesnel River valley. Sir A. Mackenzie (1793) mentions the occurrence of this tree with the hemlock at the head waters of the Parsnip. So far as at present known this is its northern limit.

On the coast it not unfrequently surpasses fifteen feet in diameter with a height of 100 to 150 feet, but such large trees are invariably hollow. The wood is good, pale yellowish or reddish, and very durable, but it is not yet extensively used except for the manufacture of shingles. From this tree the Indians split out the planks which they use in the construction of their lodges along the coast, and in the north make the carved posts which ornament their villages. They also hollow their large and elegant canoes in it, and use the fibre of the inner bark for rope-making and other purposes.

Picea Engelmanni, Parry. Engelmann's spruce.—This tree frequently surpasses three feet in diameter, and runs up tall, straight, and to a great height. It appears to characterise the interior plateau and eastern part of the province, with the exception of the dry southern portion of the former, and forms dense forests in the mountains. Varieties occur, which, according to Dr. Engelmann, who has examined my specimens, are almost indistinguishable from *Picea alba*, and to the north-eastward these varieties preponderate. Specimens collected on the Peace River plateau (lat. 55° 46′ 54″, long. 120° 20′, altitude 2600 feet) are still referable to *P. Engelmanni*, but trees on the Athabasca (lat. 54° 7′ 34″, long. 118° 48′) belong to *P. alba*. The northern and north-eastern range of Engelmann's spruce is therefore indeterminate. Englemann's spruce.

It borders nearly all the streams and swamps in the northern portion of British Columbia between about 2500 and 3500 feet in elevation. It is probably this tree which forms dense groves in the upper alpine valleys of the Rocky Mountains in the vicinity of the 49th parallel. The wood has not yet been extensively employed, but it is excellent, and in some cases very durable.

Picea Menziesii, Lindl. (=*P. Sitchensis* Carrière according to Mr. C. S. Sargent.) Menzie's spruce.—This tree seems to be confined chiefly to the immediate vicinity of the coast, where it attains a very large size, and is to some extent used for lumber. It was, however, observed on the summit between the Coldwater and Coquihalla Rivers (3280 feet); also on the Nicolume a few miles beyond the summit between Menzie's spruce

that stream and the Sumallow, and on the west side of the Spioos valley near the trail crossing. It was noted (doubtfully) on the summit between the Forks of Skeena and Babine Lake, and may probably occur in the humid region of the Gold and Selkirk Ranges. The wood is white and free.

Abies grandis. *Abies grandis*, Lindl.—Confined to the vicinity of the coast, where its range appears to be even more strictly limited than that of the cedar or hemlock. The wood is said to be white and soft, but too brittle for most purposes, and moreover liable to decay rapidly. Grows to a large size.

This tree, Mr. C. S. Sargeant remarks, may eventually be found extending further into the interior of British Columbia than we now suppose, in view of the fact that it is to be found on the Columbia as far as the Upper Cascades, and in the mountains just south of the Columbia is found at an elevation of nearly 4000 feet.

Balsam spruce. *Abies subalpina*, Engelm. (=*A. lasiocarpa* Hook.) Balsam spruce.—Appears to take the place of *Abies grandis* in the region east of the Coast Ranges. It is not found in the southern dry portion of the interior plateau, but occurs abundantly in the Gold and Selkirk Ranges in the Rocky Mountain region east of McLeod's Lake. Elsewhere it occurs in scattered groves, in the northern portion of the interior plateau, generally in localities nearly reaching or surpassing 4000 feet, but even in low valleys in the eastern portion of the Coast Ranges. It crosses the Rocky Mountains in the Peace River district and occurs in cold damp situations in the country between Lesser Slave Lake and the Athabasca River. The tree often exceeds two feet in diameter, but the wood is said to be almost worthless.

Abies amabilis. *Abies amabilis*, Douglas, (=*A. grandis* var. *densiflora*, Engelmann.) This tree is added to the list of species of British Columbia on the authority of Mr. C. S. Sargent, who communicates the fact of its discovery on the high mountain directly behind Yale, known as Silver Mountain. Prof. Sargent subsequently found this tree in Douglas' original locality south of the Columbia. He suggests that it may in some cases have been confounded with *A. subalpina*.

Pinus ponderosa, Dougl. Yellow pine, Red pine, Pitch pine.—A remarkably handsome tree, which grows only in the central dry region of British Columbia, occurring between the Coast Ranges and Selkirk and Gold Ranges northward from the 49th parallel to latitude 51° 30′ and probably also to about latitude 51° in the valley of the upper portion of the Columbia. Found also I believe sparingly on the east side of the Rocky Mountains near Waterton Lake on the 49th parallel, and on the Bow River above Morleyville. On the Similkameen this tree is seen furthest east three miles above Nine-mile Creek. On the

the Coldwater it reaches to eighteen or twenty miles from the Nicola; down the Fraser to thirty miles above Yale, and northward on the main waggon road to "the Chasm" beyond Clinton. It extends for about forty miles up the North Thompson, is found on the northern slopes of the South-western Arm of Great Shuswap Lake, and also sparingly on the southern part of the Salmon Arm. West of Okanagan Lake towards Cherry Creek nearly to the Camel's Hump Mountain.

It is pretty extensively used in the region which it characterizes, yielding sawn lumber of good appearance, but rather brittle and not very durable when exposed to the weather. It grows in open groves in the valleys, where it often occurs almost to the exclusion of other trees; and stretches up the slopes of the mountains and plateaux to a height of over 3000 feet, where it is replaced by the Douglas fir and *Pinus contorta*. Its diameter in British Columbia does not seem to exceed four feet, though further south it is said to reach a diameter of twelve to fifteen feet.

Pinus contorta, Dougl. Western Scrub pine, also called the Bull or Black pine.—Occurs throughout British Columbia from the sea-coast to the eastern slopes of the Rocky Mountains, and from the 49th parallel northward. It is the characteristic tree over the northern part of the interior plateau, and densely covers great areas. In the southern part of the province it is found on those parts of the plateau and hills which rise above about 3500 feet, where the rainfall becomes too great for the healthy growth of *P. ponderosa*. It grows also abundantly on sandy benches and river flats at less elevations. On the coast it occurs rather sparingly on sandy dunes and the most exposed rocky points, becoming gnarled and stunted. In the Queen Charlotte Islands it is scarcely seen except on the western coast, and does not occur near the water level for a considerable distance up the Skeena. In the interior it often forms dense groves, the trees being 60 to even 100 feet in height, but seldom exceeding a diameter of two feet. It does not extend upward to the timber limit in the higher mountains. The tree characteristic of the interior is var. *latifolia* of Engelmann, and differs considerably in appearance and character of wood from that of the coast to which the name *contorta* may appropriately be applied. Dall states the northern limit of this tree in Alaska to be on the Youkon at Fort Selkirk, latitude 63°. In the Peace River region it crosses the Rocky Mountain Range, and occurs more or less abundantly over a great area, generally on the higher parts of the plateau with poor soil. It is replaced by the Banksian pine at the watershed between the Athabasca and Saskatchewan, south of Athabasca Landing. Further up the Athabasca the line between these pines passes near Fort Assineboine, according to Prof. Macoun. Prof. Macoun also states that the *Pinus contorta* occurs

at the Cypress Hills, and for twenty miles east of Fort Walsh. I have little doubt that it is the same tree which clothes the upper part of the Buttes on the 49th parallel, in longitude 111°.

The wood is seldom used as lumber on account of its small size, but is white and fairly durable. The cambium layer, containing much sugar, is eaten by the Indians in the spring, and in some instances large quantities of it are collected and dried for winter use.

Pinus albicaulis, Engelm. White pine, White-barked pine.—Wood not employed as lumber; the trees being in general small and in inaccessible situations. Observed in the Coast or Cascade Ranges as far north as the Iltasyouco River (lat. 53°). Occurs in the mountains south of the upper part of the Dean or Salmon River, in the vicinity of Lillooet and at Yale, and on the summit of Iron Mountain at the mouth of the Coldwater. Noted by Mr. Sargent on Silver Mountain, near Yale, at 5000 feet elevation. The seeds are collected and used as food by the Indians.

Pinus monticola, Dougl. White pine.—This tree is abundant in certain districts of the interior of Vancouver Island, and is also found in all parts of the southern portion of the Coast Range where there is an abundant rainfall. It is found on the Hope-Similkameen trail, some miles beyond the summit on the Sumallow, about the summit between the Coquihalla and Coldwater on the Hope-Nicola trail; and to the west bank of the Spioos at the trail crossing. On the Homathco River it disappears at fifty-one miles from the sea at an elevation of 2235 feet. It re-appears in the region of heavy rainfall of the Gold Range, being abundant about Cherry Creek and on the shores of Great Shuswap and Adam's Lakes. It has not been observed in the Queen Charlotte Islands, though it may exist there. It appears to flourish best in the higher mountain regions. The tree attains sixty to eighty feet in height with a diameter of two to three feet, but is generally most abundant in situations inaccessible to the lumberer. The wood is coming into use for some purposes. It is not considered equal to that of the eastern white pine (*P. strobus*) which it resembles. The Indians collect and eat the seeds of this tree.

Chamæcypares Nutkaensis, Lamb. Yellow cypress.—Commonly known as the Yellow cedar. This tree is pretty closely confined to the vicinity of the coast and adjacent islands. It is found about Burrard Inlet, on the slopes of the mountains, several hundred feet above the sea level. On Silver Mountain, near Yale, Mr. Sargent describes a few large trees as occurring at 4000 feet elevation, and many smaller ones extending up to 5500 feet. Further north it descends to the coast. It occurs in the interior of Vancouver Island, and is abundant in some parts on the Queen Charlotte Islands, particularly on the west coast. It often exceeds six feet in diameter. This wood is as

yet comparatively unknown in commerce, but is strong, free and of fine grain, with a pale golden yellow tint and a slight peculiar resinous smell. It is very durable and has been used to a limited extent in boat-building and for various ornamental purposes.

Larix occidentalis, L. Western larch.—Is found in the Rocky Mountains and in the valleys of Selkirk and Gold Ranges, its limit there being co-extensive with that of abundant rainfall. Stretches westward nearly to the head of Okanagan Lake. The summit between Osoyoos Lake and Kettle River was called Larch Tree Hill by the Boundary Commission expedition, this being the first place at which the tree was found abundantly in travelling eastward. Not found on the coast. The timber is said to be strong and durable but coarse.

A species of larch, which from imperfect specimens submitted to him Dr. Engelmann supposed to be *L. Americana*, occurs abundantly in swampy spots on the Peace River plateau and on the Athabasca.

Larix Lyallii.—Specimens of this tree which, according to Mr. Sargent, is evidently a distinct species, were collected by Lyall in the "Galton Range," which lies immediately west of the Rocky Mountains near the 49th parallel. Very little is known about this larch.

Taxus brevifolia, Nutt. Yew.—Occurs on Vancouver Island, and on the shores of the mainland adjacent, attaining sometimes a diameter of two feet. It is found as large as eighteen inches in diameter on the Fraser as far up as Chapman's Bar, near the Suspension Bridge. It also occurs on the Coquihalla for twenty miles above Hope, and is found on the Lower Skeena. Not found, or very sparingly, in the Queen Charlotte Islands. A very tough hard wood of beautiful rose color, employed for various ornamental purposes. Formerly used by the Indians in making bows, spear-handles, fish-hooks, &c.

Juniperus virginiana, L. Juniper, Red cedar, Savin.—Has been observed assuming an arboreal form along the shores of Kamloops, François and other lakes, and elsewhere, with a diameter of about one foot. Also observed at Esquimalt and Departure Bay, Vancouver Island. Commonly know as pencil cedar.

Acer macrophyllum, Pursh. Maple.—Found on Vancouver and adjacent Islands, and on the mainland in the immediate vicinity of the coast northward sparingly to latitude 55°, and in the Queen Charlotte Islands. Never found inland. Occasionally attains a diameter of four feet. A valuable hard wood, sometimes well adapted for cabinet-making, and also used as fuel.

Acer circinatum, Pursh. Vine maple.—Like the last strictly confined to the vicinity of the coast, but does not appear to go far north. A small tree, seldom over a foot in diameter, but yielding a very tough and strong white wood, which is used, in the absence of ash, for the manufacture of helves, &c.

Pirus rivularis, Dougl. Crab-apple.—Occurs along the coast of Vancouver and Queen Charlotte Islands, and the whole coast of the mainland of British Columbia. On the Skeena abundant to the mouth of Lakelse and a few trees seen at ninety miles from the sea. A small tree or shrub. Wood very hard, but liable to check, susceptible of a good polish, and especially valuable in those parts of mill machinery intended to withstand great wear. Fruit prized by the Indians as food.

Pirus sambucifolia, Cham. and Schlect. Mountain ash.—Sparingly in various parts of the interior of the Province. A small tree or bush.

Amalanchier alnifolia, Watson. Service-berry, 'la poire.'—Occurs on Vancouver Island and very rarely and in a stunted form in the Queen Charlotte Islands. Abundant in some parts of the interior plateau and beyond the Rocky Mountains to the north-eastward in the Peace River country. Generally a shrub. Under favourable circumstances a small tree. The wood is very hard and is used for various purposes by the Indians. The berrries are dried and stored away in large quantities for winter use.

Quercus Garryana, Dougl. Oak.— Flourishes in the south-eastern portion of Vancouver Island, though Mr. A. C. Anderson mentions the existence of a few trees a mile and a half above Yale, on the Frazer River, and these Mr. Cambie informs me are still to be seen. Reaches a diameter of three feet and a height of about seventy feet. Used for flooring and other purposes in building, and also in the manufacture of barrels and kegs. A hard wood but not very tough. It spreads along the inner coast of Vancouver Island northward to Nanaimo, and occurs also on Quatsino Sound still further north, though there very scarce. I have not observed it myself in the last-named locality, but its occurrence is vouched for on good authority.

Alnus rubra, Bongard. Alder.—Attains the dimensions of a small tree on Vancouver and Queen Charlotte Islands and the coast of the mainland. On the Lower Fraser sometimes two feet in diameter. The wood is easily worked, being well apapted for turning and susceptible of a good polish. It is largely employed in Portland, Oregon, for the manufacture of furniture. Also used for the manufacture of charcoal.

Betula occidentalis, Hook. Western birch.—A small tree generally belonging to the dry interior flora. Found pretty widely distributed in British Columbia, and according to Prof. Macoun on both branches of the Saskatchewan, but the precise limits of range not known.

Betula papyracea, Ait. Paper birch, Canoe birch.—This tree appears to find its southern limit on the Lower Frasor and occurs in a number of localities in British Columbia, and abundantly in the Peace River district.

Populus tremuloides, Michx. Aspen poplar.—Abounds over the whole interior of the province, growing everywhere in the north and characterizing some of the most fertile lands. In the southern dry portions of the interior found usually along the borders of streams, and on the higher plateaux. First noticed in abundance on the Skeena at about 110 miles from the sea. It forms the usual second growth after fires in the Peace River country. Attains frequently a diameter of two feet.

Populus trichocarpa, T. & G. Cottonwood.—There is some difficulty in separating this tree, a western form, from *P. monilifera* and *P. balsamifera* in the northern and north-eastern part of British Columbia. The eastern species *P. monilifera*, according to Mr. Sargent, certainly extends across the continent into Alaska. Prof. Macoun informs me that he believes *P. trichocarpa* does not occur on the Fraser above Yale, while he found *P. balsamifera* on the Parsnip and Peace Rivers, and in the river bottoms of the South Saskatchewan and its tributaries *P. monilifera*. These poplars are commonly included under the name of 'Cottonwood,' and are found in the valleys of streams and on the banks of rivers generally throughout the province and in the Peace River district, attaining sometimes a diameter of four to five feet. Used by the Indians of the interior for the manufacture of canoes. *P. triohocarpa* is now largely employed at some places on Puget Sound in the manufacture of staves for sugar barrels which are used at San Francisco for the Sandwich Island crop.

Arbutus Menziesii, Pursh. Arbutus, Madrona.—Occurs on Vancouver and the neighbouring islands, but never far from the sea. It is sparingly represented as far north as Seymour Narrows. A very handsome evergreen yielding a white close-grained heavy wood, resembling box. Attains a diameter of from eighteen inches to two feet, and a height of fifty feet.

Cornus Nuttallii, Aud. Dogwood.—On Vancouver Island and the coast of the mainland adjacent, attaining the dimensions of a small tree. Wood close-grained and hard.

GEOLOGICAL SURVEY OF CANADA.

ALFRED R. C. SELWYN, LL.D., F.R.S., F.G.S., DIRECTOR.

REPORT

ON

HUDSON'S BAY

AND SOME OF THE LAKES AND RIVERS LYING TO THE WEST OF IT.

BY

ROBERT BELL, M.D., F.G.S., C.E.

1879-80.

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MONTREAL, May 4th, 1881.

A. R. C. SELWYN, ESQ., LL. D., F, R. S.,

Director, Geological Survey:

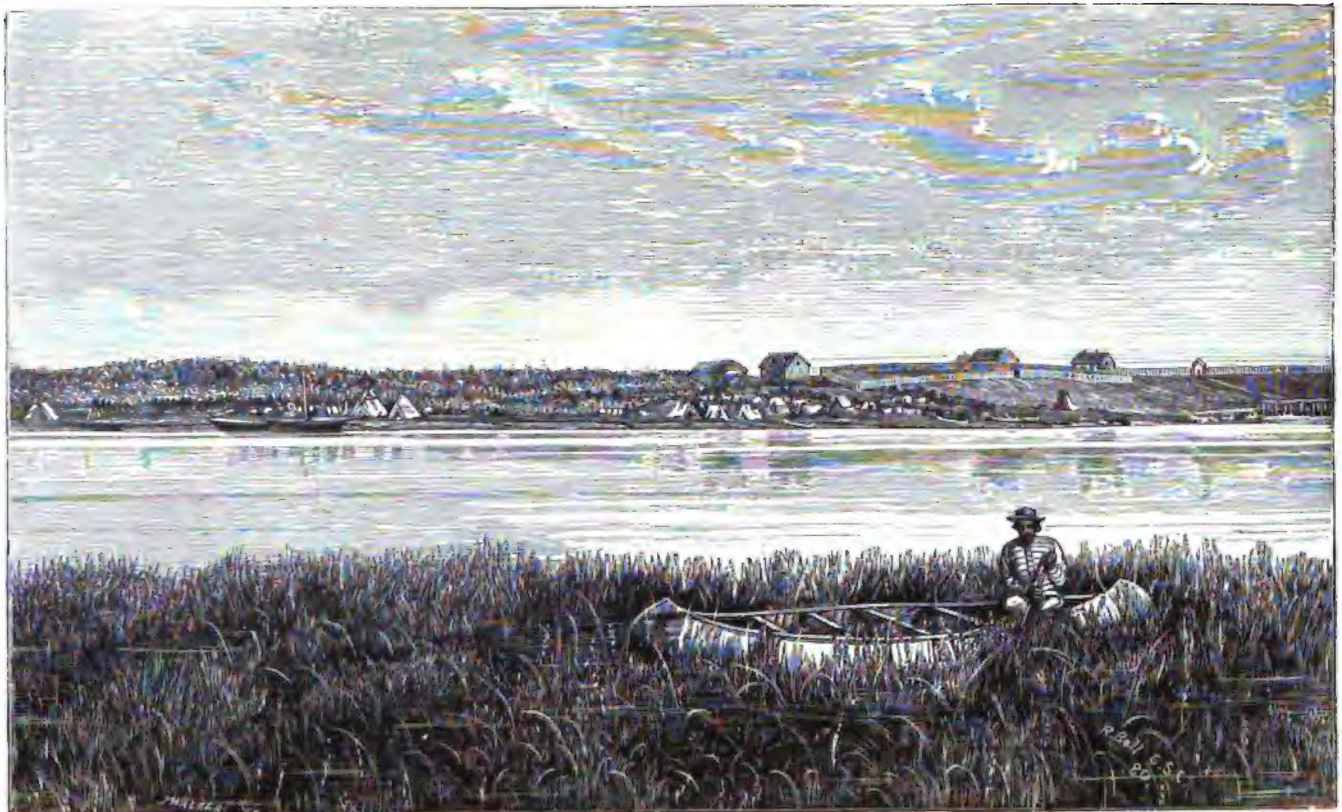
SIR,—I beg to submit, herewith, my report for the year 1879–80.

I have the honor to be,

Sir,

Your obedient servant,

ROBERT BELL.



GEOLOGICAL SURVEY, 1880.

From a Photograph by DR. BELL.

OXFORD HOUSE—LOOKING SOUTH-EAST.

REPORT

ON

HUDSON'S BAY

AND SOME OF THE LAKES AND RIVERS LYING TO THE WEST OF IT.

BY

ROBERT BELL, M.D., F.G.S., C.E.

The explorations of myself and assistants during the summer of 1880 had for their object the continuation of those of the two previous years in the region lying to the west of Hudson's Bay. I was instructed to return home through Hudson's Strait; and the Hudson's Bay Company kindly allowed me a passage by their ship from York Factory to London. It was hoped that an opportunity might thus be afforded of ascertaining something of the geology of the shores of the strait, and it fortunately happened that a great part of its northern and southern shores were seen during the passage, and also the principal islands which lie within it. To the officers of the Company residing in the country we are again indebted for many favors and much valuable assistance. Among others from whom such courtesies were received I may mention the Chief Commissioner, Mr. Graham, Messrs. J. H. McTavish, W. Flett, R. Ross, C. Sinclair, J. Fortescue, W. Clark, H. Belanger and P. Deschambault. Object of explorations. Acknowledgment of aid.

Mr. A. S. Cochrane was again my assistant, and we were also aided by Mr. Charles A. Molson, B.A., and Mr. Charles A. Lawford, of Montreal, both of whom accompanied the party as volunteers. All these gentlemen performed their duties in an efficient and satisfactory manner. Assistants.

Reaching Winnipeg on the 16th of June, we hoped to be able to proceed at once to Norway House, the proposed starting point of the three divisions of our party, after obtaining the necessary Indians,

canoes, &c. The steamer "Colville" was, however, the only means of doing so, and it was nearly a month later before she started on her first trip to Norway House. The interval was profitably employed in making a variety of preparations, procuring supplies, constructing maps, taking photographs of the characteristic scenery of the province, making geological examinations and collecting natural history specimens, including a collection of fossils from the limestone of the Red River in the parish of St. Andrews, and at the newly opened quarry at East Selkirk. This collection will be examined and reported upon by Mr. Whiteaves. We landed at Norway House on the 17th of July, and with the kind assistance of Mr. Roderick Ross, the gentleman in charge, immediately made arrangements which enabled Messrs. Molson and Lawford to proceed in one direction, and Mr. Cochrane in another, while I took a third, having given full written instructions as to all matters which the branch expeditions were expected to attend to. Nearly all the supplies and outfit required, with the exception of canoes, had been brought with us, and these were furnished by Mr. Ross, who also aided us in securing good canoemen, and allowed us the use of a building in which to store our provisions and baggage.

Preparations.

Fossils.

Division of party.

Messrs. Molson and Lawford were instructed to make track surveys and geological examinations of the part of Cross Lake on the Nelson River which had not already been examined by myself, and of the whole of Walker's Lake, lying a short distance to the east of it. Mr. Lawford was obliged to return to Montreal on the completion of this work, and Mr. Molson, with two canoemen, was directed to make a similar survey and examination of a lake situated a short distance east of the Nelson River, between Cross Lake and Lake Winnipeg. This sheet of water is known to the Indians of the neighborhood as Winnipegosis, but in order to avoid confounding it with the larger and better known lake of the same name (to the west of Lake Winnipeg), it is proposed to call it Molson's Lake, after the gentleman to whom we are indebted for the first exact knowledge concerning it. After completing the survey of this lake, Mr. Molson, having to wait about two weeks for an opportunity to return home, spent the time in going over a part of the line which was being run by the Chief Engineer of the Nelson Valley Railway & Transportation Company, on the north-west side of the Nelson River.

Cross Lake.

Molson's Lake.

Line of Nelson Valley railway.

One of the objects of the present season's explorations being to trace out the boundary between the Cambro-silurian limestone and the more ancient rocks to the north-westward, from the foot of Lake Winnipeg, Mr. Cochrane was instructed to proceed to the western extremity of Cross Lake, and thence to traverse the country to the south-westward, by way of Pine River and Moose Lake and River to the Saskatchewan,

Boundary of Cambro-silurian limestone.

Cross Lake to the Saskatchewan.

GEOLOGICAL SURVEY. 1880. From a Photograph by DR. BELL.

TEN-SHILLING CREEK, NEAR YORK FACTORY.

which he was then to ascend to Cumberland House. Thence to make his way northward to the Churchill River at Frog Portage, and to descend this river to its junction with Deer River from the northward, ward, which discharges the waters of the Reindeer Lake. He was next to ascend the river to the lake, and then to make a survey and and examination of as much of its shores as the season would permit. **Churchill River** **Reindeer Lake.**

In the event of Mr. Cochrane finding it impossible to complete his exploration of Reindeer Lake before winter, he was to remain either at the lake itself or as near as possible to it, and to be guided in his operations next season by the instructions he might receive before the opening of navigation, and in the meantime endeavor to map his work and report the results as far as possible. A sufficient stock of provisions, &c., for his use was sent to Cumberland House, even if he should require to spend the winter in the country. **Wintering in the country.**

Mr. Cochrane has completed all the work prescribed except a portion of Reindeer Lake. The winter set in while he was exploring its shores, and he resolved to remain at the Hudson's Bay Company's post at the northern part of the lake. Mr. Deschambault, the gentleman in charge, had a shanty built for him, and before the end of January he had prepared his report and maps showing his explorations. These documents reached Montreal in March: The maps will require to be corrected for latitude, variation of the compass, &c., and carefully compiled on a smaller scale for publication, which can best be done after the completion of the explorations of the coming season. An abstract of Mr. Cochrane's report on last season's work will be given further on. **Work accomplished.**

Having completed the foregoing arrangements, I left Norway House on the evening of the 20th of July, and followed the same boat route to York Factory of which a track survey was made in 1878. The latter post was reached on August 1st, but having spent three days at Oxford House, only nine days were consumed in travelling, and even this allowed time for stopping frequently on the way. Some additional notes were made on the geology of the region traversed, the latitudes of a few points determined, a number of interesting photographs obtained, and some zoological and a large number of botanical specimens were collected. While awaiting the sailing of the Hudson's Bay Company's ship "Ocean Nymph" on her annual return voyage to London, I was kindly entertained by Mr. Fortescue, the Chief Factor in charge of York Factory. **Norway House to York Factory.**

The ship formerly often reached this port early in August, but for the last few years she has had orders to call first at Churchill Harbor, and is now somewhat later in reaching York Factory; this year she was considerably later than usual, but being daily expected, I could not venture far from the factory. The time, however, was usefully **Date of arrival of ship.**

employed in making more detailed examinations of the estuaries of the Hayes and Nelson Rivers, taking photographs of the characteristic scenery of the neighborhood, observations for latitude, and in collecting botanical and geological specimens, &c.

Bishop of Moosonee.

The Bishop of Moosonee, who had been spending two years in this part of his extensive diocese, was also at York Factory, waiting to take passage by the same ship to England. Having been aware in 1879 of His Lordship's intention to visit Trout Lake and the Severn River during the spring of 1880, I had requested him by letter to observe the rocks he might pass on his way, with a view to discovering any bands of the Huronian system which might exist in that direction. Judging from the specimens and information which he kindly gave me on his return, it is inferred that a belt of these rocks crosses the Trout Lake branch of the Severn River just below the outlet of that lake. The specimens collected by the Bishop at this locality consist of a very dark, coarsely crystalline diorite or hornblende rock, containing crystals of dirty, greenish-grey felspar; dark, compact felsite, and dark, fine-grained hornblende schist. Further down, in the banks of the Trout Lake River, he noticed beds of gravel cemented together by calcareous matter. These extend for a considerable distance along the stream, and large blocks of the rock which have rolled down to the beach form a conspicuous feature of this part of the river. His Lordship kindly brought a specimen of this rock, and also of a light-colored fossiliferous limestone which he reports as occurring abundantly in the bed of the river about twenty-five miles above Fort Severn, and which no doubt belongs to the Cambro-silurian system.

Trout Lake.

Huronian rocks.

Cemented gravel.

Fossiliferous limestone.

Arrival of ship.

The "Ocean Nymph" arrived on the 4th of September, and was ready to sail again on the 10th, but calm weather prevented her doing so, and she was subsequently detained by a gale from sea until the 13th, on the evening of which we cleared the land. An abstract of the notes taken on the voyage, until well out in the Atlantic Ocean, is given further on. The "Ocean Nymph" is a barque of about 320 tons. On arriving from sea she anchors in York Roads or the channel of the North or Nelson River, opposite the Point of Marsh or the extremity of Beacon Point, until a Pilot is sent out. Then, having secured a favorable wind, she sails at high tide into Hayes River, where, while discharging and loading cargo, she lies at anchor in the middle of the main channel, half a mile wide, directly in front of the Factory. Here, at low tide, the water is ten or twelve feet deep, and upwards of twenty feet at high tide. On the present occasion, the "Ocean Nymph's" draft of water on entering was about twelve feet, and on leaving only between nine and ten feet. A ship drawing more than this could not apparently come up the stream to York Factory.

Ship's anchorage.

The larger vessels which formerly brought the goods for this establishment were therefore obliged to remain at Five-fathom Hole, in the mouth of Hayes River, about seven miles from the Factory.

Cross Lake and Walker's Lake.

The western part of Cross Lake was mapped in 1878, and during the present season Messrs. Molson and Lawford completed the survey of the remainder of its shores, and we now have a complete map of the whole lake. Its main body proves to be nearly straight, with a general course of about N. 60° E. (mag.), and a length of about fifty-four miles. Its width varies from four to seven or eight miles, except in the ten miles at the eastern end, where it is only about one mile wide. From a point in the middle of the lake, opposite the most easterly of the outlets, the arm on the east side of the Indian Reserve Island extends southward a distance of sixteen miles. The western channel of the Nelson River from Great Playgreen Lake, and also a stream called Pine River, enter the western extremity of the lake. The Indians, by ascending a creek at the north-east extremity of the wide part about a mile, and thence by a portage about three miles long, leading northward, come to a pond, from which the water flows to White Rabbit Lake. This again discharges into Sipi-wesk Lake. The Mistasini or Big-stone River falls into the north-eastern extremity of Cross Lake. A canoe-route which begins here soon leads to one of the head branches of the Fox River, which may, it is said, be easily descended by canoes to that stream, and this again to its junction with Hill River. The Indians are reported to follow this route occasionally in travelling between York Factory and Norway House. Another canoe route is said to exist between Cross Lake and the lower part of the Nelson River. Some of the Indians stated that Cross Lake has an outlet near its north-east extremity, but this was found to be an error.

Survey of Cross Lake.

Pine River.

White Rabbit Lake.

Fox River.

Towards the north-east end of the lake there is a considerable bay on the south-east side, the eastern extremity of which receives the river or narrow strait, two and a half miles long, which leads, in an easterly direction, into Walker's Lake, so called after an Indian in whose hunting grounds it is situated. This sheet of water has the same level as Cross Lake, and the set of the current between the two is frequently determined by the direction of the wind. Walker's Lake runs S.S.W. (mag.), and has a length of nine miles, with a breadth of four miles. Both lakes contain many islands, scattered over all parts of their surface.

Walker's Lake.

Cross Lake is so named from the fact that it lies transversely to the general course of the Nelson River. This river may itself be regarded as flowing across the lake, since its milky-looking water extends only

Water of Cross Lake.

between the inlets and outlets,—the water of the southern arm and of the main body of the lake to the north-east of the outlets being transparent, with a slightly brownish tint.

Surrounding country.

The country around Cross and Walker Lakes has a generally level appearance. Much of it appears to be rocky, but a good deal of clayey soil was observed at various parts of the shores of the lake. The forest is mostly green or unburnt, and consists of spruce, Banksian pine, tamarac, Canada balsam, white birch, aspen and balsam-poplar, together with willows of two or three species, pigeon cherry (*Prunus Pennsy lvanica*), common and green alder (*Alnus incana* and *A. viridis.*), and rarely the rowan or mountain ash (*Pyrus Americana*).

Timber.

Rocks.

The Huronian rocks of the western part of Cross Lake were described in the report for 1878. On the north-western side of the lake, to the eastward of the outlets, Mr. Molson found only Laurentian gneiss, except at Poplar Point, about half-way up the shore, where a band of micaceous hornblende schist occurs in a vertical attitude; strike, S. 55° W. (mag). The same band was seen on the opposite shore in the continuation of this. Gneiss was the only rock found upon Walker's Lake. The character and strike of the gneiss were recorded in a considerable number of places around both lakes, and these observations are useful in mapping the geology of this region, but they do do not require to be described in detail. It may be mentioned, however, that taking the average of all the courses noted, the general run was found to be S. 45° W. and S. 80° W. (mag). The rock in different parts presents considerable variety as to texture, mode of lamination, &c., and various shades of red and grey were observed on both sides. The directions of the glacial striæ, which were noted in a number of places around Cross Lake, were found to vary from S. 45° W. to S. 50° W.

Hornblende schist.

Gneiss.

Strike.

Glacial striæ.

Molson's Lake.

Molson's Lake.

White-water River.

The White-water River, by which this lake is reached, joins the Echimamish from the south at about seven miles east of the short portage over the height of land dividing its channel, or two miles above Robinson's Lake. From this point the outlet of Molson's Lake lies at a distance of only three and a-half miles in a straight line, bearing S. 35° W. (mag.),but the river makes a curve to the westward, which increases the distance to five miles. Four rapids occur in the White-water, but they can all be surmounted by canoes, except the last, which requires a portage of 120 yards to be made in order to pass it. The greatest length of the lake, which is about eighteen miles, lies in an E- N. E. and W. S. W. direction. The outlet is situated at about one-third of the entire length from the north-eastern end, and the broadest

part of the lake, about eight miles across, is just opposite to it. From this part the width diminishes regularly to either extremity.

A small stream, known as Pine River, falls into the north-east end, and another called Pai-musk-taban Sipi, or Marshy Canoe-route River, enters the south-western extremity. A canoe-route from the Echimamish passes up the White-water River, through Molson's Lake, and then follows up the latter stream, which is sluggish and marshy, in a south-westerly direction, to its source in a muskeg, or open swamp, at a distance of eight or ten miles from the lake. A trail from this muskeg passes over some rocky ground, and emerges on the Nelson River above Sea River Falls. Canoe-route.

On the north side of the Pai-musk-taban Sipi, near its mouth, a perperdicular cliff of gneiss rises to a height of about 100 feet. The face of the cliff runs S. 38° W. (mag.), and is marked by horizontal glacial striæ. On this cliff are some small figures in red ochre, said to have been painted by the father of the present chief of the colony of Indians which removed a few years ago from Little Playgreen Lake to Fisher River, on the west side of Lake Winnipeg. The largest pictures are not more than one foot high, and most of them do not exceed eight inches. They represent a boat, canoe, tortoise, bird, deer, otter, Indian, pipes, &c., and are spoken of by the Indians as being much more wonderful than they really are. Painted figures.

The eastern part of Molson's Lake is surrounded by a rocky country. Some of the hills or bluffs rise to a height of upwards of 100 feet above the water. Boulders are unusually prevalent about the margins of this lake and White-water River, but a clayey soil, bearing good-sized spruce and other timber, occurs in some places. Surrounding country.

Gneiss, principally of a grey color, is the only rock found around this lake. Its general strike is between S. W. and W. S. W. It nowhere presents any peculiarities worthy of special description, as far as Mr. Molson could observe. The general course of the glacial striæ around the lake was found to be from S. 30° W. to S. 40° W. Rocks. Glacial striæ.

The water of Molson's Lake is transparent, with a greenish tinge, and it is well stocked with fish. Among them is the grey or lake trout, which is found only in the clearer lakes of this region. Whitefish, suckers, pike, pickerel, dogfish, &c., also occur in abundance. Fish.

Exploratory Surveys by Mr. A. S. Cochrane.

In referring to the instructions given to Mr. Cochrane, the various routes which he was to follow were indicated. The result of his labors will now be given from the information contained in his preliminary report and maps, as well as in his letters. For this purpose each of the sections explored will be described under a separate heading. Five Result of Mr. Cochrane's labors.

well-executed maps, showing these explorations on a scale of four miles to the inch, have been received from Mr. Cochrane. The length of the track survey represented on each is as follows:—

	Miles.
1. Between Cross Lake (on the North River) and Cumberland House...	242
2. Between Cumberland House and Pelican Narrows................	196
3. Between Frog Portage (into the Churchill River) and outlet of Rein-deer Lake..	102
4. Boat-route through Reindeer Lake from the outlet to Du Brochet Post, at the north end..................................	175
5. Shore line of northern part of Rein-deer Lake..................	250
Besides these, Mr. Cochrane made surveys in the vicinity of Cumberland House and Du Brochet Post amounting to sixty-six lineal miles..	66
	1,031

Exploration from Cross Lake on the Nelson River to Cumberland House.

Cross Lake to Cumberland House.

In making this exploration Mr. Cochrane ascended the Pine River, which discharges into the south-western extremity of Cross Lake, and from its source, by means of a portage 2,600 yards in length, across a height of land, he gained Moose Lake, which empties by a short marshy stream into one of the winding channels of the Saskatchewan, in the low country between the Pas Station and Cedar Lake. In ascending the Saskatchewan to Cumberland he cut off the Big (northward) Bend by passing through the lake round which it flows, and ascending for a short distance the Birch River, which discharges into this lake. Passing over the Birch Portage, 4,400 yards in length, across the neck of land between this river and the Saskatchewan, he again came out upon the latter near the junction with the Tearing River, flowing from Pine Island Lake, on the south side of which Cumberland House is situated.

Course and distance.

The general upward direction of Pine River, from Cross Lake to Moose Lake, is south-west, and the distance about eighty miles. The height of land separating the two waters is just east of Moose Lake, so that the portage from the head of Pine River falls directly into Moose Lake. Hill's Lake is a widening of the river about half way up. Drunken Lake occurs about half way up the lower stretch, and Lily Lake about the middle of the upper one. From Cross Lake to Drunken Lake the river is wide, and the banks are covered with small timber, consisting of poplar, birch, Banksian pine and balsam fir. Tolerably good soil, composed of clay with a little sand, was seen in a few places. Drunken Lake lies to the south of the general course of Pine River, which passes through its northern part, and another river, whose name could not be ascertained, falls into its southern extremity. Very coarse

Hill's Lake.

Timber.

grey-ribboned gneiss, containing small garnets, and running S. 72° W., was met with about half way from Cross Lake to Drunken Lake, and on the south and west sides of the latter gneiss, consisting of light and dark grey bands, occurs; but the strike is here S. 37° E. From Drunken to Hill's Lake, a distance of twenty-three miles, the river passes through a flat and swampy country. For the first twelve miles the banks are three or four feet above the water, but in the last eleven the river passes through continuous swamps and reedy marshes, the stream on either side being closely lined with willow bushes. Hummocks of grey gneiss, with a varying strike, stand up in several places in the low gronnds between the two lakes.

Grey gneiss.

Flat country.

Grey gneiss.

Hill's Lake is about twelve miles long, and from one-half to three-quarters of a mile wide. It is surrounded by precipitous banks of fine stratified clay, from twenty to twenty-five feet in height. The fossiliferous limestone was first met with at the upper or south-western end of this lake. The exposure is in the form of a cliff, thirty feet high. The rock is of a light brownish color, and holds fossils similar to those found in the parish of St. Andrew's, on Red River. The river just before falling into this end of the lake passes over a shallow rapid one mile and a-third in length, with a limestone bottom. Several smaller rapids are passed before reaching Lily Lake. They are mostly over broken limestone, but at one of them this rock, which is all of the same light brownish color, occurs in *situ*, and dips S. 45° W. at a small angle. Lily Lake is quite small. Its banks are about twenty feet high, and are well wooded with birch. Above this lake the stream becomes little more than a brook, which is generally so narrow or shallow as barely to allow a canoe to pass. The country through which it flows, as far as the Height-of-Land portage, is all swampy, except at the various rapids. The navigation of this part of the stream is rendered more difficult from its being much obstructed by beaver dams, which are sometimes from five to eight feet high. The Height-of-Land portage, which is about a mile and a-half in length, passes over wet, marshy ground, with the exception of a space of about 200 yards of flat limestone, which occurs about the centre.

Clay banks.

First limestone.

Beaver dams.

Height of land.

Mr. Cochrane had not time to make a complete exploration of Moose Lake. The portion which he passed through from the above portage to the outlet is about forty miles long, and lies in a south-westerly direction. A number of large islands lay near his course, and several bays stretched away to the eastward beyond the horizon, but no reliable information as to their form or extent could be obtained. Another deep bay, on which an Indian reserve is situated, stretches to the westward of the southern part of the lake. Limestone similar to that of Lake Winnipeg was seen at a few places on the north-western shore.

Moose Lake.

Limestone.

The dip in all cases was to the southward. No fossils could be found. The southern bay of Moose Lake comes within about three miles of a "lost" channel of the Saskatchewan River, and is connected with it by means of a very narrow creek, winding, with no perceptible current, through a large marsh, in which the reeds and grass had grown so high as to completely obstruct the view from a boat. It is a remarkable fact that the water at the northern end of Moose Lake was very clear, while that at the southern extremity was quite muddy, owing apparently to the Saskatchewan, which was at a very high stage, backing its waters into the lake. There is a post of the Hudson's Bay Company at the south end of Moose Lake, and here Mr. Cochrane was informed that the Saskatchewan had not been so high since 1872, and that last year (1879) it had been extremely low.

Water of Moose Lake.

High water.

Nothing new was noted in ascending the Saskatchewan to the Pas. The Birch River flows into the south-western extremity of the lake, which is included within the Big (northern) Bend, just above the Pas. It is a deep, sluggish stream, with low marshy borders, fringed with willows near the mouth; but in ascending it the banks rise gradually, till they have attained a height of fifteen feet above the high-water level at Birch portage, seven miles up. On the Indian reserve at this locality the land had been partly cleared along the bank of the river, and planted with potatoes, which looked particularly well. The land was all that could be desired, very fertile, with a clay bottom, covered with rich, dark yellow and black sandy loam. Birch portage itself, which is two and a-half miles long, passes over excellent land, which for the first half of the distance is clear of timber and covered with a very luxuriant growth of bushes and wild grass, and bears a close resemblance to the country near the banks of the lower part of the Red River. The northern half of the portage lies through a thick growth of timber, consisting principally of balsam-poplar (*Populus balsamifera*), some of the trees being fully two and a-half feet in diameter. White elm (*Ulmus Americana*) comes next, both as to abundance and the size of the trees. The green ash (*Fraxinus viridis*) is also abundant, and a few maples (*Negundo aceroides*) and aspens (*Populus tremuloides*) are likewise to be seen. The white spruce (*Abies alba*) here attains a large size. A short distance above the northern end of the Birch portage, a narrow neck of land between the Saskatchewan and the Tearing River was crossed by means of a portage trail. The latter stream, in which the water was very high, was ascended to Pine Island Lake, and Cumberland House was reached on the 10th of August. Here Mr. Cochrane received the greatest kindness and every assistance from Mr. H. Belanger, the Hudson's Bay Company's officer in charge.

Birch River.

Good soil.

Timber.

Tearing River.

Cumberland House to Frog Portage.

After surveying some of the channels in the neighborhood of Cumberland House, and making the necessary preparations for the work of the rest of the season, Mr. Cochrane left this post for Reindeer Lake on the 16th of the same month, in company with Mr. Deschambault, the gentleman in charge of the Hudson's Bay post on that lake, who had come down to Cumberland House to obtain his season's outfit of goods. Mr. Cochrane was afterwards indebted to Mr. Deschambault for much kindness and valuable assistance. **Cumberland House to Frog portage.**

In going northward from Cumberland House to Pelican Lake, instead of taking the usual route, leaving the east end of Pine Island Lake, which has been described by various travellers, Mr. Cochrane, in company with Mr. Deschambault, followed another route lying considerably to the westward, which starts from the western extremity of Pine Island Lake. **New route followed.** The first part of the journey was due north (mag.) up the Grassberry River, a distance of thirty-five miles, to Windy Lake. **Grassberry River.** This is a narrow stream with many bad rapids, which at first are among large Laurentian boulders and loose masses of limestone, but in the last ten miles they are over smooth beds of limestone, all of which is similar in character to that of Moose Lake and Lake Winnipeg. **Limestone.** The country through which this river passes is flat and swampy, with the exception of a strip 300 or 400 yards wide along either side of the stream. The timber, however, is often good, and consists of balsam-poplar, white spruce and Banksian pine. **Timber.** Shrubby balsam fir, and a thorn like that of Manitoba, were also seen.

Windy Lake is small, and receives the Balsam River from the north-east. Two cliffs of limestone, like the last, each about twenty feet high, occur on the south side. Leaving this lake the route passed through Narrow River, three miles long, connecting it with Little Pelican Lake, which is about twenty miles long. **Little Pelican Lake.** The next part of the route was up Blackfeet River from the north side of the last-mentioned lake. This river, which is narrow and crooked, has a course of about twenty miles, in which the rise amounts to eighty feet. The rapids and chutes were over ledges of limestone, all of the same character as the last, which cross the bed of the stream, and often have hard boulders resting upon them. **Limestone.**

Blackfeet Lake, at the head of the river of the same name, is surrounded by a more hilly country than the lakes and rivers already described. **Blackfeet Lake.** Its immediate shores are generally about ten feet high, but at the south end the banks are fifty or sixty feet in height, and appear to be of clay, on which there is a thick growth of spruce timber. The same limestone occurs on a number of the points, but no fossils could be

discovered in any of it. Lobster (Cray-fish) Lake, the next one on the route, is connected with the north-western extremity of the last by a rapid, over beds of limestone, with a rise of about five feet. It is only two miles long, and is surrounded by clay banks about ten feet high.

Big-stone River. Big-stone River, three miles long, with a rapid over flat limestone at its head, leads up to the lake of the same name. The surrounding country

Hilly country. is now still more hilly than that around Blackfeet Lake. The timber, which is small, consists of the same kinds as we noticed on the Grassberry River, with the addition of tamarac (*Larix Americana*).

From Big-stone Lake a winding and rapid river, only five miles in

Limestone Lake. length, with a rise of twenty-six feet, is followed up to Limestone Lake. At both the mouth and head of this stream, which is called Limestone

Gneiss. River, fine-grained reddish and gray gneiss, was met with in *situ*, the strike being south, while on the lake itself the flat limestone was the only rock seen in place.

Height of land. The height of land, separating the waters just described to the south from those flowing northward into Pelican Lake, runs past the west side of Limestone Lake. Only a short portage of 300 yards is necessary in order to cross the dividing ridge to a pond, on the east side of which almost perpendicular hills of the stratified limestone rise to the height of about one hundred feet. From this pond the Limestone portage, nearly two miles long, leads to the south end of a lake about twenty miles in length, which Mr. Cochrane (in the absence of any other name) called Deschambault Lake, in honor of his *companion-de-voyage*. The portage for the most part passes over bare flat-bedded limestone, the surface of which is much broken up; but about a quarter

Deschambault Lake. of a mile before reaching Deschambault Lake it is suddenly replaced by dark reddish gneiss, which strikes S. 40° E., and dips to the S. W. This lake has a northward course, and near the middle is divided by narrows. In two places near the south end Mr. Cochrane found close-

Mica schist. grained, finely-stratified mica schist, with veins of white and pinkish quartz. The strike in one case was S. 40° E., and in the other S. 10° E. Gneiss occurs about the middle of the lake. It is both coarse and fine-grained in texture, grey in color, all very micaceous, and holds many viens of white, purplish and claret-colored quartz. The northern or lower half of the lake is nearly round in outline. Bear

Bear River. River flows in at its western and out at its eastern side, where it falls over two chutes, the first of twenty-six and the second of fifteen feet. Here the river passes between high and nearly bare hills. On the east side they are composed of granite, and on the west of schist, the line

Granite and schist. separating the two kinds of rock having a N. N. W. course. Coarse grey gneiss, containing large garnets, appears a few miles further down Bear River.

Bear River discharges into Pelican Lake, which is upwards of twenty miles long, in a northerly direction. It is surrounded by steep and nearly bare hills of gneiss and granite. Those on the west side rise almost perpendicularly to a height of between 200 and 300 feet, but on the east side, and around the north end, their height does not exceed 100 feet. Both reddish and grayish varieties of granite were met with. The gneiss is mostly grey. In the southern part of the lake the strike is a little east of south, and at the northern a little west of south. A post of the Hudson's Bay Company, called Pelican Narrows, and two mission stations, are situated on this lake. Mr. Cochrane arrived at the former on the 25th of August, the distance from Cumberland House, by the route followed, being about 190 miles. He was unable to continue his track-survey from this point to Frog Portage, at the Churchill River, a distance estimated at between forty and fifty miles, owing to the heavy rains, which prevailed. Perhaps the most important geological fact noted in this interval is the occurrence at Burntwood Lake of Huronian schists with serpentine. Frog Portage, on the south side of the Churchill River, was reached on the 27th of August.

Pelican Lake. Granite. H. B. Co.'s post. Mission stations. Serpentine.

The Churchill River from Frog Portage to the Junction of Deer River.

Frog Portage, which is 315 yards in length, is not past a rapid on the Churchill River, but leads from the south bank of that stream to the commencement of the route southward to Cumberland House. Deer River, discharging the Reindeer Lake, joins the Churchill twenty-seven miles below Frog Portage. Its average width in this distance is about one mile. Its course is northward, and the upward direction of the lower thirty miles of Deer River is about the same, and its character similar. Many rocky islands occur in both. The immediate banks of this section of the Churchill are low, but the country on either side rises gradually, for a distance of one-half to three-quarters of a mile from the water's edge, to heights varying from 100 to 400 feet. The slopes on the right, or eastern side, are sparingly covered with poplars and what appeared to be a second growth of birch; while on the hills on the left side the timber is nearly all spruce, forming, apparently, the original forest, although the trees are all small. The rocks consist of grey gneiss, with a general south-westward strike. The country near this part of the Churchill is very barren, only one patch of soil—clay—having been observed between Frog Portage and the junction of Deer River. Kettle Fall, four miles above the junction, is passed by a portage on the left side 150 yards in length. The descent here is about twenty feet. The water of the Churchill is very clear.

Churchill River. Deer River. Character of country. Timber. Kettle Fall.

Deer River.

Deer River. The distance from Churchill to the outlet of Reindeer Lake, following the general course of the river, is seventy-five miles. Deer River is a splendid stream: large, deep, and comparatively easy to navigate with boats. The current is strong in some places, but only four portages are met with throughout its course. They are all short, the longest measuring only 260 yards. It receives four large rivers, two from the east and two from the west, besides a considerable number of brooks. It ranges from less than half a mile to one mile in width. Its waters, as well as those of the four tributaries, is very clear, indeed.

Branches.

Mountainous country. The country on either side is rough and mountainous. Near its mouth the hills average about 200 feet in height; about half-way up they become lower, not often exceeding 100 feet, but towards the head of the river they increase in height until they attain an elevation of 500 feet above the rapids at Rock Portage, which may be considered the outlet of Reindeer Lake. Patches of soil of a few acres in extent were seen at some points along the eastern stream, but otherwise the whole country seemed barren. The timber, which is small and poor, consists principally of spruce, but aspen, balsam-poplar, birch and Banksian pine were often seen. At one place, not far below the outlet, a good deal of tamarac was observed, but, although the trees were tall, they were of small size. The rocks consist entirely of grey and reddish gneiss. The general strike along the lower part of the river is S. S. E., and along the upper part about S. S. W. The outlet of Reindeer Lake was reached on the 1st of September.

Timber.

Gneiss.

Reindeer Lake.

Reindeer Lake. This great sheet of water, according to Mr. Cochrane's map, is about 175 miles in length, and between twenty and thirty in width, except in the fifty miles at the southern end, where it is much narrower and full of large islands. Great bays run off from both sides in this part. Messrs. Cochrane and Deschambault left the outlet on the 2nd of September, and reached the Hudson's Bay Company's post (called Du Brochet), near the upper end of the lake, on the 6th, so that there was very little opportunity on this journey for sketching in the shores. Before the close of navigation, or between the 10th and 27th of the same month, Mr. Cochrane managed to make a track survey of 250 miles of the coast line around the northern part of the lake.

Du Brochet Post.

Track survey.

The course of the boat-route, which was followed through the lake from the outlet to Du Brochet Post, was almost due north (mag). It was near the east shore, and passed from island to island, coming near the mainland at two-thirds of the distance up. Mr. Cochrane

thinks his estimate of the length of the lake is not more than ten or, at the most, fifteen miles in error.

In the southern part of the lake the banks on either side are high and precipitous, varying from 200 to 400 feet above the water. They are composed entirely of gneiss, which is thickly covered with small timber. At the north end of the lake, on the other hand, no hills are to be seen, and the surrounding country, as far as could be seen, where not muskeg or rock, is barren and sandy. The timber is here all very small. Small patches of clay occur at the Hudson's Bay Company's post, and about the middle of Perch Bay, a long narrow arm which forms the northern extremity of the lake. Reddish granite occurs at Du Brochet Post, and on an island near the east side of the lake, about fifty miles to the south of it. At all other parts of the lake the rocks, wherever examined, consisted of greyish gneiss, the usual strike of which is south-westward. Character of the surrounding country. Rocks.

Mr. Cochrane, having spent the winter at Du Brochet Post, will be able to make a much earlier start in the spring, and, besides, having accomplished more field-work last autumn, will have saved considerably in travelling expenses. Advantages of wintering in the country.

The last letter received from him was dated 31st of January. He was keeping a meteorological register, including readings of the thermometer and barometer, and observations of the winds, clouds, &c., noted three times a day. The winter had so far proved milder than he had expected to find it, fine weather having prevailed up to the above date. Ice began to form around the lake on the 12th of October, and by the 20th it had frozen to a considerable distance from shore. Up to the end of January snow had fallen to a depth of one foot and a-half on an average in the woods. Towards the end of this month the reindeer, or barren ground caribou, began to pass Du Brochet Post in great numbers, moving southward. About the end of March it was said they would begin to return northward, on the ice of Reindeer Lake, towards the barren grounds, where they breed. At the time of the return migration the snow has mostly disappeared from the land, and the surface of the ice on the lake affords excellent travelling. The lake is not free of ice till the middle of June. Meteorological register. Climate. Reindeer.

On the opening of navigation Mr. Cochrane proposes to devote one month to the completion of the track survey of Reindeer Lake, after which he is instructed to proceed westward through Wollaston Lake to Lake Athabasca, making as complete topographical and geological explorations as possible, to Fort Chippewyan, from which he is to return to Manitoba by way of Methy Portage, Isle à la Crosse Lake and Cumberland House. In this way it is expected that much valuable information will be obtained. Wollaston Lake discharges into Reindeer Lake by the Continuation of work in 1881: Wollaston Lake

Swan, Canoe, or Hatchet-lake Rivers. It is said to discharge also into Athabasca Lake by more than one outlet. The rivers which thus lead from Reindeer Lake to Lake Athabasca are reported to be large and good for canoe navigation. The distance from Du Brochet Post to Fort Chippewyan by this route is estimated at about 450 miles. Serpentine is believed to occur on Wollaston Lake, Mr. Cochrane having been shown a pipe and a cup carved out of this mineral, which he was informed was found there. Sir John Richardson remarks that sandstone, like that of the great boulders at the Methy Portage, is reported to exist in *situ* towards the east end of Athabasca Lake. Mr. Roderick Ross, of Norway House, who formerly lived at Fond du Lac, on this lake, informs me that graphite and other minerals occur in the neighborhood of that post.

Lake Athabasca. Serpentine. Sandstone. Graphite.

NOTES OF A VOYAGE, IN 1880, FROM YORK FACTORY, HUDSON'S BAY, TO LONDON, BY THE BARK "OCEAN NYMPH," 320 TONS, BELONGING TO THE HUDSON'S BAY COMPANY.

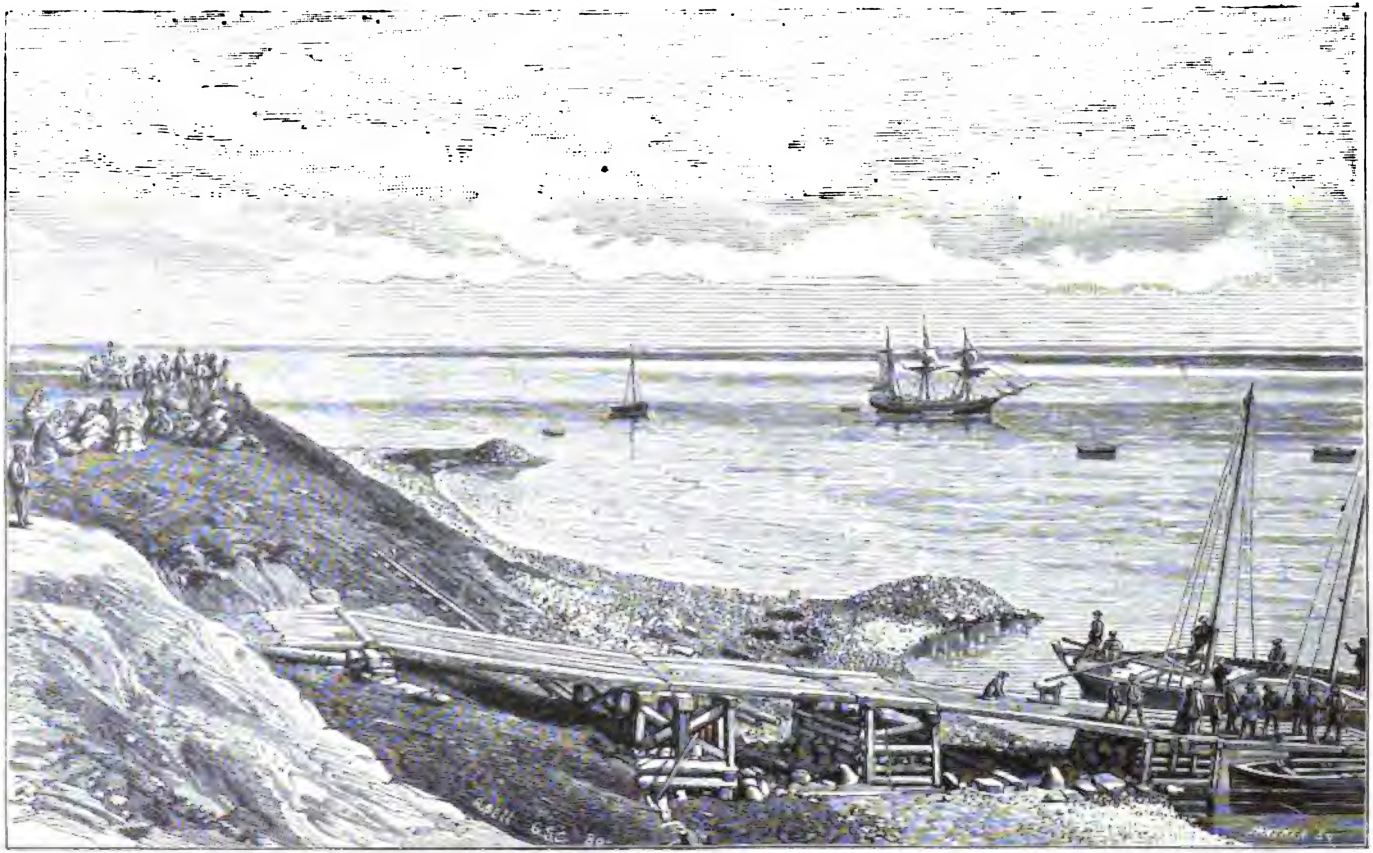
Ship's company

Monday, September 13*th*, 1880.—The ship lying in the middle of the Hayes' River, opposite York Factory, all ready for sea, her company consisting of Captain John McPherson, commander; John Hawes, first officer; E. G. Miller, second officer; steward, cook, carpenter, eight seaman; and, as steerage passengers, ten retiring servant-men of the Hudson's Bay Company; as cabin passengers, the Right Revd. John Horden, D.D., Bishop of Moosonee, and Dr. R. Bell (the writer). A bright, clear day at York Factory, with light wind from the S.W. Get both anchors up, and make sail just before high water. The ship begins to move at 3.15 p.m. Follow the buoyed channel, in charge of a pilot, to beyond the Five Fathom Hole, when the pilot leaves us to return to the Factory. After passing the outer or checked buoy, our course is more northward than the line of buoys leading out from the mouth of the river. The light breeze, which had hitherto been from the S., now shifts to W., N.W., and finally N., so that we are obliged to take an easterly course towards the Tatman Land. The water becoming too shallow in this direction, put the ship about, and make towards Nelson Shoal as night comes on.

Start on voyage

Head wind.

Tuesday, September 14*th*.—Dark and hazy last night, especially towards morning. Brightening up between 6 and 7 a.m., and is quite clear, but overcast, at 9, with fresh breeze from the E. The wind, from the same quarter, increases all day, and is quite strong at 7 p.m., with a rough sea. Have been obliged to carry as much canvas as possible all day, so as to keep off the land, but at dusk are obliged to shorten sail. Although the ship is very light the water has been coming over the deck on the lee side. The sun not having been visible all day, no



From a Photograph by DR. BELL.

VIEW AT YORK FACTORY, LOOKING OUT TO SEA.

latitude has been obtainable, and owing to the great lee-way the ship is making (over two points) our position at dusk is not very certain, but is supposed to be about thirty-five miles off the mouth of Broad River. Temperature of the sea at 8 p.m., 40° Fah.

Wednesday, September 15th.—Wind strong and steady from E. all day. Sailing five or six knots an hour, but making much lee-way. Sea rough. Barometer lower than yesterday, and still falling. At 6 p.m. our position, calculated by dead reckoning, is ninety miles to N.N.E. of Cape Churchill. Temperature of the sea at 8 p.m., 41° F. **Off Cape Churchill.**

Thursday, September 16th.—Light wind from S. all day, the speed of the ship varying from three to five knots an hour. Weather clear in the morning, but dull in the afternoon. Latitude at noon, 60° 04′. Temperature of the sea at 8 p.m., 41° F. After dark this evening the ship left a tolerably luminous wake, in which numerous phosphorescent balls appeared.

Friday, September 17th.—Light wind all day, shifting from S. to W. and N.W., and in the evening being nearly N. Rate about three to five knots an hour all day. Sea water very clear. Pleasant moonlight evening. Smooth sea. In conversing about the fishes of Hudson's Bay, it was said that the common salmon is reported to run in the smaller rivers of Hudson's Strait, as well as in the rivers flowing into Ungava Bay, where it is well known to be extremely abundant. In coming out this voyage the captain saw a dead haddock floating in the strait. The Bishop has heard of a few "real" cod having been caught near Whale River, and I have seen plenty of rock cod taken at various places on the east coast of James' Bay. There appears to be no reason why the common cod should not be found in Hudson's Bay. The conditions as to temperature, depth of water, &c., are favorable, and its food, especially the capelin, is abundant. The latitudes of the prolific fishing-grounds of the Atlantic coast of Labrador are the same as those of Hudson's Bay. The question whether or not cod fishing-grounds are to be found in this great bay is so important that it deserves a thorough trial. **Fishes of Hudson's Bay.** **Cod.**

Saturday, September 18th.—Light wind all day. Rate varies from two to five knots an hour. Sea smooth. Temperature of water at noon, 41° F.; of air in the shade, 41° also. Clear and bright all day.

Sunday, September 19th.—Another fine day, with smooth sea. Sky cloudless in the morning, but more or less overcast in the afternoon, with a little fine rain towards evening. Latitude at noon, 62° 18′. Between 10 a.m. and noon a considerable number of white porpoises passed westward, the first ever seen in this part of the bay by the captain. In the afternoon pass much large flat sea-weed (*Laminaria*) floating on the surface. Haul in an average specimen, and find the **Fine day.** **White porpoises.**

frond to measure ten feet in length. A small five-rayed star-fish was sticking to the base of the thick round stalk. The sea is streaked by currents running parallel to the ship's course. Temperature of sea at noon, $39\frac{1}{2}°$ F.; air about the same. In the afternoon we get a distant view of the northern part of Mansfield Island; at 6 p.m. are about twenty miles to the N.W. of it. It has a low, even outline. The first officer has walked over several miles of the country on the northern part of this island, having spent several days there some years ago. From his description of the rocks I suppose them to consist of trappean strata and bedded grey quartzites similar to those of the Hopewell and Nastapoka Sound groups, which I examined in 1877. The strike on Mansfield Island, according to Mr. Hawes, would be parallel to its greatest length, and the dip mostly westward. The captain says that in sounding off this island, he once brought up a small piece of coal from the bottom of the sea. This is an interesting fact in connection with the occurrence of anthracite on Long Island, on the Eastmain coast. (See Report for 1877.) From descriptions of the strata of some parts of the Southampton group of Islands, I should judge that rocks similar to those of the Nastapoka group occur there also.

Mansfield Island.

Volcanic rocks.

Coal.

At ten this morning the bell rang for Divine Service, and the Bishop read prayers and preached a sermon to the passengers and crew assembled in the open air on the main deck. Altogether a beautiful forenoon; the decks dry and clean, and the air so mild and sunny that our ordinary coats were sufficient for comfort while attending service, during which everyone remained with head uncovered. Service again, on the open deck, at 4 p.m. Being the "dog-watch," nearly the whole of the passengers and crew attended, forming a congregation of upwards of twenty.

Beautiful weather.

Divine service on deck.

Monday, September 20th.—Early this morning came up to some drifting "bay" ice, and shortened sail, and hove-to till daylight, after which it fell calm, and remained so all forenoon. Latitude at noon, 62° 55′. Many small, reddish, gelatinous creatures in the water. Small fishes, resembling sardines in size and appearance, swimming past the ship's side. Grey, speckled water-fowl basking in the sun on the surface of the smooth water. During the afternoon, a light wind blowing from the direction of the drifting ice prevented us, owing to the slight hold the ship has on the water, from entering amongst it for some hours, as we wished to do, in order to pass through it on our course. The most the ship could be induced to do was to keep her bows "looking" towards it, while she was allowed to drift gradually southward. However, we were sailing among the "pans" of ice before dark.

Drifting ice.

Calm.

Fish and water-fowl.

Tuesday, September 21st.—Light head wind all the time till towards

evening, when it freshens. Keep topsails, jib and spanker set all day, tacking slowly about among the bay ice. Occasionally the vessel would lie for a few seconds quite still against an unusually large "pan." Owing to her bad sailing and the light wind, she has been merely dropping, almost broadside, from piece to piece, sometimes on the one tack, and sometimes on the other, according as she happened to turn when balancing against each pan of ice she encountered, or according as it yielded to her pressure at one end or the other. Almost the whole of the ice which we sailed amongst to-day is discolored with fine brownish earth on the surface, as if it had drifted over it, as dust in the winter, when it was forming along shore, showing that it must have come from some coast, where banks or beaches of fine material, such as clay, sand or mud, exists. All the pans have their angles rounded off, and look soft and spongy. The larger ones have generally a depression, containing water, in the centre. They are evidently much worn and melted, being all undermined at the edges, and sometimes projecting more broadly below than above water. Many of them are composed of layers agglomerated at different angles. The tops of the highest pans would be four or five feet above the water, but most of them are small and flat. When they are bowled over by the ship they generally leave a whitish-looking cloud of mud in the water around. In addition to the light brown coloring of the ice, there are sometimes darker patches and black-looking spots, which, on close inspection, prove to be the dung of seals and other animals. **Earth on the ice.**

A ship, supposed to be the "Prince of Wales," in charge of Captain Bishop, from Moose Factory, was sighted early this morning, and remained in view all day, a long way to the northward. Latitude at noon, 62° 56′. **"Prince of Wales."**

Wednesday, September 22nd.—During the night the captain sailed the ship back to near the position occupied yesterday afternoon, so that we are still to the northward of Mansfield Island. Sail slowly all day in a south-easterly course by compass, or about true E. Day mostly overcast, with a flurry of snow towards evening. A snow-bird remained some time in the rigging to-day. A peep of sunshine now and then in the forenoon, during which observations are obtained. In the evening we are moving a little faster, about two miles an hour. Owing to the lightness of the wind and the great lee-way made by the ship, we could not get through a little isthmus of drift ice, which could have been crossed in ten minutes by a steamer. The delay caused by our inability to do this may affect the whole of the rest of the voyage more than we can foresee. **Disadvantages of sailing vessels.**

Thursday, September 23rd.—Early this morning many white and some brown (young) porpoises were seen around the ship. Moving very **Porpoises.**

slowly all day among scattered pans of ice before a light air, never sufficiently strong to fill the sails or to be perceptible on the water. At dusk we reckon we have made about twelve miles in the twenty-four hours since last evening. Set up my camera on the poop, and after adjusting it so as to take in a good view of the surface of the sea, dotted with flat patches of ice, which were about equally distributed all over, put in a "quick," dry plate, and waited for hours in the hope that the ship might be brought to a momentary stand-still, when a rapid view of the pans might be taken. Although the pressure on the sails was so very light, the ship never for a moment ceased moving on, until, when I was about to take away the instrument in despair, one of the officers kindly brought her up purposely for a few seconds, and an almost instantaneous picture was obtained, which serves to show the proportion of ice to water surface. All the ice-pans passed to-day have also been dusted over with brown and light grey mud. On one pan saw a small quantity of light-colored, angular gravel, apparently limestone. From early morning till the middle of the afternoon the sea remained as smooth as a mirror, after which a gentle swell from the eastward began to be felt. Between 5 and 6 p.m. get into water almost free of pans, but the drift ice still visible on our port or northern side. Had a glimpse of the sun about 11 a.m., and obtained the latitude, which was nearly the same as yesterday. After a dull, overcast day, a yellow sun-set bursts through the haze. Let down the deep-sea lead at noon and 8 p.m., but find no bottom in either case at 150 fathoms. Our position is supposed to be in mid-channel, between Nottingham and Digges. At 4 o'clock this morning the temperature of the air was 31° F.; of the sea, 30°; at noon—air, 34°; sea, 31°; at 8 p.m.—sea, 36°.

Photography. Gravel. Calm. Deep water.

In the course of the day saw a few seals and some small fishes near the ship. Some grey and some black water-fowl were also seen swimming about a short distance off. A ptarmigan flew past the ship. Calm, foggy evening; but at 11 o'clock to-night a light air moves the ship a knot and a-half an hour. "Sea phosphorus" is now rising to the surface in the clear water around the ship. It resembles "fire-flies" in the air on a warm summer's night. The captain says the drift ice we have just passed through is much worse than any he saw in the straits on the outward voyage. This rather surprised me, as it did not appear at all formidable compared with the continuous ice I have passed through in a steamer going from St. John's, Newfoundland, to Halifax, where it covered the sea completely for the greater part of the distance. He says it is very unusual to meet ice at all in this part of his track, neither he nor the first officer having seen it before. They say the straits are always clear towards Digges, and that a steamer, by going close to the south side in that quarter, could always be sure of a

Seals, fishes and water-fowl. Calm water. Phosphorescence. Steamer amongst drift ice.

Fig. 1.

CAPE WOLSTENHOLME, SOUTH SIDE, WESTERN ENTRANCE, OVER 1000 FEET HIGH.

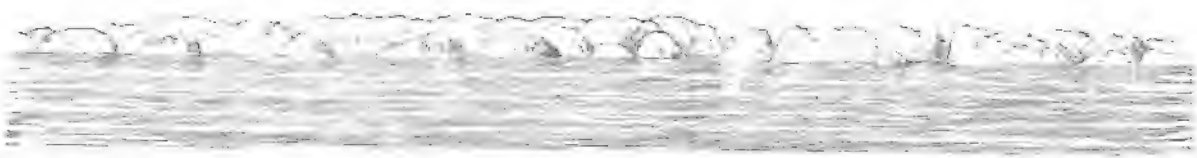


Fig. 2.

OUTLINE OF COAST EAST OF CAPE WOLSTENHOLME, SOUTH SIDE, SEPTEMBER 25TH.

ABOUT FIFTEEN MILES DISTANT.

free passage at any time; but this might sometimes be dangerous with a sailing vessel, where so many contingencies require to be considered, especially if she could not be depended upon to work to windward. When drifting ice has been seen off this end of the straits earlier in the season, it has appeared to be pressed against Southampton, Nottingham and Salisbury Islands, with points projecting occasionally to the southward and eastward. The freedom from ice enjoyed by the opposite side is supposed to be due to the west-flowing tide up the straits, and the northward current up the Eastmain Coast. **Position of drifting ice**

Friday, September 24th.—Early this morning many white porpoises were seen about the ship. Foggy all day. Sailing slowly along in smooth water, with a light north-easterly breeze. At 4.45 p.m., while sailing S. E. (mag.), the fog lightening a little, we come suddenly in sight of land, three or four miles off. The fog continuing to lift as we get closer in, we obtain a good view. It proves to be one of the Digges (islands), with Cape Wolstenholme behind. The mainland sinks out of sight about thirty miles off to the right or S. W. (mag). The island presents a front of two or three miles in width before us, but seems to run further back to the south-east. It is almost bare rock, with a sand beach in the centre, and rises to a height of about 500 feet. It shows some high cliffs, evidently of greyish gneiss, some of which is strongly banded, the bedding being on an average perpendicular, and the strike directly away from us, or S. E. (mag). Behind this island Cape Wolstenholme rises fully 1,000 feet, or probably more, and shows some very bold cliffs or bluffs, in some cases overlooking inlets or deep coves. The general outline of the top of the land maintains about the same elevation above the sea. A few small patches of old snow remain in shady ravines. The appearance of the land at this place is given in the accompanying outline sketch. (Fig. 1.) **White porpoises.** **Digges.** **Cape Wolstenholme**

Saturday, September 25th.—Rather dark and foggy during last night. Ship made some progress to the eastward. The accompanying sketch (Fig. 2) represents the appearance of the land to the south of us, at 6 a.m. The locality is some 20 miles east of Cape Wolstenholme, and the sketch is taken at about fifteen miles off. Some deep, narrow bays or inlets run in between the high cliffs of this part of the coast line. One of them evidently makes an angle at a short distance back, and looks as if it might afford good shelter for vessels. The general outline of the top of the land is about 1,000 feet above the sea, and is horizontal for some distance abreast of us, but diminishes in height to the eastward. There is a slight "dusting" of fresh snow on the tops of the hills, and small patches of old snow are visible in a few shady nooks. These hills are evidently composed of Laurentian gneiss, as they bear a close resemblance to those of the Eastmain Coast, between Nastapoka and **Inlets.** **Laurentian gneiss.**

Hopewell Sounds, which were examined closely in 1877. One white porpoise was seen to-day. Some black divers, with white breasts, were swimming near the ship in the forenoon. The weather has been beautiful to-day, with light winds. At noon we had gained only thirty-five miles eastward in the previous twenty-four hours, but owing to the light winds our progress is no doubt much influenced by the tides. In the evening, the air being mild and pleasant, walk on the poop, in company with the first officer, enjoying the bright moonlight; the sea very smooth, and having considerable phosphorescence. The wake of the ship is full of "stars and balls of fire."

Beautiful day.

Mild evening.

Sunday, September 26*th.*—A mild, sunny morning, with light wind from the northward, which continues all forenoon. At 10 a.m. the Bishop again held service on the main deck, and preached a sermon. No overcoats and only ordinary clothing worn by the congregation. Some of the sailors and servants attended in their jerseys, and others in their shirt-sleeves. All present remained with bare heads during the whole of the service. Salisbury Island was in sight during forenoon. The hills on it are either flat-topped or angular, and somewhat separated from each other, having the appearance of a Huronian rather than a Laurentian country. In the afternoon the sky becomes overcast, and the wind very changeable, but unfavorable, and as the men are kept constantly busy working the sails, no afternoon service is held. Only thirty-two miles forward had been made in the twenty-four hours up to noon to-day. The weather begins to be rough and disagreeable in the evening, and a steady head-wind has set in at bed-time.

Service on deck

Salisbury Island.

Monday, September 27*th.*—Very disagreeable weather. A rather strong head-wind, with sleety snow at intervals all day. Cold and disagreeable. All sails have been carried during daylight, but at dusk the royals are taken in as a precaution, although the wind is not strong. Sea very phosphorescent. A bleak look-out for the night. The captain remarks, "If we had a ship with a screw in her stern we should be in London to-night."

Disagreeable weather.

Tuesday, September 28*th.*—The wind died away early last night, and it remained nearly calm till morning. Made only fourteen miles from six o'clock last evening till eight this morning, when a very light breeze sets in from S. S. E. Mild, pleasant morning; air clear, but sky overcast. At 9 a.m. a small iceberg from Fox's Channel is floating abreast of us, two or three miles to the north. Before noon the wind comes from the south-westward, with a clear, blue sky, and good observations are obtained. Latitude at noon, 63° 11′; long., 73° 33′. Breeze very light at noon. At this hour the north-east point of Charles Island lies S. S. W., nearly thirty miles off. It shows a series of undulations or hills with long slopes. High land is also visible to the N. N. E., which

Charles Island.

the Captain says is the north shore, some fifty miles to the westward of the Upper Savages. At 1 p.m. the wind veers around to the E., or nearly dead ahead. Sail northward till 4 p.m., when we go about. At this point the land along the north side of the Strait is near enough to distinguish its character plainly. The rocks are evidently Laurentian. The highest part is between longitude 72° of the chart and the inlet to the S. E. of it. The wind, which is still ahead, freshens at sunset, and the weather turns colder.

Wednesday, September 29th.—Strong head-wind, with haze and rain all day. Raining hard at dusk. The night setting in very dark, shorten sail. The sea very phosphorescent; its temperature at 8 p.m., 32½° F. Ship pitching considerably, and the wind making a great howling in the rigging. **Heavy rain.**

Thursday, September 30th.—The weather began to clear up towards morning, but the wind continued ahead, and the sea rough, so that with the shortened sail we are only able to hold our ground. The air turning milder this morning. After daylight the weather continued to clear. The sun shone out at nine, and we obtained an observation. The land about Cape Weggs is visible during the morning. It is high and undulating. One berg visible astern of us, and several pieces of ice in a row floating down the north side of the strait. Wind comes from various quarters during the day, and we sail about in different directions. At one time we were within seven or eight miles of the north coast to the N. W. of Drake's Inlet, where the accompanying sketch (Fig. 3,) was taken looking north-eastward. The central part represents an island. The range of hills on the mainland is about 2,000 feet high. A few small patches of snow visible on the highest parts, principally in one locality.

Friday, October 1st.—Clear, bright morning. Sea calm, with slight swell, but glassy surface. Warm sunshine all forenoon, and during most of the afternoon. As the Bishop remarked, "The day is simply beautiful." Between 11 a.m. and noon the thermometer registered 47° in the shade. Land visible at the same time on both sides of the strait. That on the south side is not so high as on the north, but it presents abrupt faces to the sea, with an even general outline, while on the north side the hills rise gradually for a long distance back, and the outline varies much in height. These characters appear to apply to the respective sides of the strait throughout the greater part of its length. Several seals and divers swimming about the ship and basking in the sun. Air so calm that for a considerable time the ship would not answer the helm, and turned about in any direction. A little motion in the air at one time moved her slowly back stern first. A number of small bergs seen in a row down the strait, north of the **Warm sunshine** **Comparison of the two sides of the strait.** **Small bergs.**

central line. They are more or less undermined, and show water-marks running up them at various angles, from their having turned at different times, owing to melting away and parts breaking up disturbing their previous balance. They are all very white and spongy, looking as if old or far-travelled. Some of them had spots of dirt, and on one a dark patch of considerable size was seen. After sunset a high but increasing breeze from the west springs up, and we run two, three and four miles an hour. At 10 p.m. it is quite dark, but still the little bergs can be seen with the aid of a good binocular.

Variable wind. *Saturday, October 2nd.*—Wind sufficiently fair early this morning to sail on our course at the rate of three knots an hour; but it heads us after 8 a.m., coming from the N. E., and remains from that quarter all day. **"Prince of Wales."** At 6 a.m. a ship, supposed to be the "Prince of Wales," made her appearance, following us till she came within five or six miles, when she put about and soon disappeared towards the south side of the strait. During the forenoon she re-appeared, at first as a speck, but soon came near enough for us to make her out to be the vessel we had supposed. **North Bluff** Tack about during the day, abreast of North Bluff. The appearance of the land in this neighbourhood, from a distance of ten to fifteen miles, is represented in the accompanying outline sketch. (Fig. 4.) North Bluff itself is near the middle of the view, Point Lookout at the left, or N. W., and the Upper Savages at the right, or S. E. extremity. Some small spots and streaks of old snow on the top of the highest hills above North Bluff, a few miles inland. **Row of small bergs.** A good many small bergs seen to-day, most of them in a row, going down the strait between us and the North Bluff. Passed close to one which shows a wake on the sea behind it, as if it were being borne along by an under-current. Both sides of the strait have been plainly visible. The appearance of the land on the south side, at what is said to be the western point or horn of King George's Sound, **King George's Sound.** is shown in the accompanying outline sketch, (Fig. 5,) taken about fifteen miles to the N. E. of it. A slight sprinkling of new snow has fallen on the hills on this side.

Sunday, October 3rd.—Very light north-easterly winds, or nearly calm all day. Overcast in the forenoon, with a streak of bright sky near the horizon, and sunshine on the water to the northward of us. At 1 p.m., sun shining also around the ship, and to the southward. The "Prince of Wales" in sight behind us all day. Only twenty-seven miles gained from noon yesterday till noon to-day. **Mild air.** The air being still and mild, the Bishop again held service and preached a sermon, on the open deck, at 10 a.m. A long sermon and service again on deck at 4 p.m. On both occasions the men wore only their jerseys or jackets. **Service held on deck.** This is the third consecutive Sunday in the strait on which service has been held in the open air, on the deck of the ship, without discomfort.

Fig. 3.

NORTH COAST, N. W. OF DRAKE'S INLET, ABOUT LONG. 72°, HILLS NEARLY 2000 FEET HIGH.

SEVEN MILES DISTANT.

Fig. 4.

NORTH COAST BETWEEN POINT LOOKOUT AND THE UPPER SAVAGES, INCLUDING N. BLUFF.

TEN TO FIFTEEN MILES DISTANT.

Fig. 5.

WEST POINT OF KING GEORGE'S SOUND, SOUTH COAST, LOOKING SOUTH-WEST.

FIFTEEN MILES DISTANT.

Fig. 6.

SOUTH POINT OF RESOLUTION ISLAND, NORTH SIDE OF EASTERN ENTRANCE, OCTOBER 8TH.

The surface of the sea has been glassy most of the day. Passed considerable numbers of black-backed divers in flocks resting on the smooth water. In the morning passed twelve or fifteen miles to the N. E. of Prince of Wales Island, which has a flattened dome-like outline. The land behind it presents rather steep faces to the sea, and is somewhat broken up into bays or inlets. In mid-channel the land was visible to the naked eye on both sides at the same time. When nearest to North Bluff an open space could be seen between the point of the mainland and the nearest of the upper savages. The captain and first officer describe North Bay as having a high, steep or perpendicular cliff running round its western and north-western sides. The currents are so strong in this bay that if a sailing ship got too far in she might find it difficult to get out again. Large brown sea-weeds (*Laminaria*) floating near the surface in considerable quantities to-day.

Divers.

Land visible on both sides.

Large sea-weeds.

Monday, October 4th.—The wind was free enough to sail on our course during the early part of last night, but headed us again before midnight, and this morning the ship is plunging considerably with a rather strong head-wind. Towards noon the wind lulls, and the weather, which had been overcast all night and this morning, with more or less drizzle, cleared up, and the sun shone out for half-an-hour between 12 o'clock and 1 p.m. In afternoon overcast again, with occasional drops of rain, and almost calm. Total run for twenty-four hours to noon, forty-seven miles. Last night we passed two icebergs, but only two (possibly the same) were seen during the day. A snow-bird flew on board the ship, and was easily captured and placed in an empty cage, which happened to be in the cabin. (This bird began to eat "canary seed" as if it had been accustomed to it, and was taken in good condition all the way to London). This morning the "Prince of Wales" passed across our stern, about four miles off, on the opposite tack.

Clearing weather.

Tuesday, October 5th.— Bright, pleasant morning. Sun shine and blue sky, with fleecy white clouds; settled looking weather. During the forenoon, however, it becomes overcast, and in the afternoon it turns out raw and foggy; but in the evening it clears up again and becomes mild. Temperature of the water in the morning, 34°; in the afternoon, 31½°. Between 5 and 6 p.m. sight Green Island, lying about fifteen miles due south of us. Its outline is rather high and undulating. This island is seldom seen by vessels passing through the strait. The "Prince of Wales" in company behind us this afternoon. At 6 p.m. she was only three miles off, and sailing in the same course as ourselves. At 8 p.m. both ships burn blue lights, and afterwards show lanterns. Light southerly winds have prevailed all day. Between last evening and this morning our rate has varied from one to three and a-half knots an hour. Some snow has rested on the ship

Bright morning.

Green Island.

Pleasant evening.

to-day. Found it pleasant walking on the poop in the evening, without gloves or overcoat.

Wednesday, October 6th.—Mild and pleasant in the forenoon, with a light, fair wind. Sun shining for a short time, during which observations were obtained. A very large seal came to the surface, and followed close under the stern of the ship for some minutes. The "Prince of Wales" was seen a good way behind us at 9 a.m. A fog came rapidly over the water about the middle of the day, and the afternoon was raw and chilly. Soon after the fog came on a flock of rock ptarmigan (*Lagopus rupestris*) made their appearance around the ship. From the confused manner in which they flew about, they had evidently lost their way in the fog. At first there were not less than thirty or forty, but they were so frightened by the men trying to catch them that they gradually disappeared, some falling into the sea. Only two were captured, one in molt (mottled) and the other white.

Rock ptarmigan.

Thursday, October 7th.—Sailed slowly all last night, as the weather was rather thick, and we are nearing the narrowed outlet of the Strait, where the currents are apt to carry a vessel out of reckoning. Clears off for a while in the morning, and we get observations of the sun at 9. At 10 the "Prince of Wales" is about four miles to the N. E. of us. In the forenoon a flock of "Eskimo" (eider) ducks passed us, going south, and flying close to the surface of the water. About 11 a.m., wind light from N.W., but fog coming on we take in sail, so as to run only a mile and a-half an hour. Foggy all the rest of the day. During the afternoon we were visited by several flocks of rock ptarmigan. There were between forty and fifty birds in the largest. The captain says they are on their way from North Bluffs to the south side of the straits. This time the men allowed them to settle on the spars and ropes of the ship, and by means of nooses attached to short sticks they captured a considerable number. They were much relished at supper, not only by the crew and passengers, but also by the golden eagle and silver fox which we are taking to the London Zoological Garden. They were mostly mottled, and in different stages of molt. Two seals were noticed this evening along side the ship. The fog clears off in the evening. The night, however, proves too dark to run out of the strait, although the wind is fair, but light.

Nearing outlet of straits.

Eider ducks.

Flocks of ptarmigan.

Friday, October 8th.—At one o'clock this morning the vessel began to move and at daylight there was a considerable swell. On going on deck find the ship hove-to (although wind is fair from the N.W., and the weather very bright), waiting to ascertain our position, no land being visible. A little before noon get the latitude, and finding ourselves in the middle of the channel, immediately square away, and run eight to nine knots an hour before the wind. This forenoon a flock of eider

Bright weather

ducks and one ptarmigan passed us, going south. It is said that from the ships either in going or coming few or no geese are seen crossing the strait. At 3 p.m. we cross a strong stream of tide running in. Our position at 5 p.m. is about ten miles south of Hatton's Headland, or the south point of Resolution Island. Its appearance at this distance is represented in the accompanying outline sketch. (Fig. 6.) The Button Islands, to the south, are also visible in the distance,. The weather has been bright all day, and so mild as to be very pleasant walking on the poop. **Geese.**

Saturday, October 9th.—Wind continued fresh from the N.W. all day. Ship going regularly about eight knots an hour, but rolling very much, although the sea is running fair after, and all the sails which will draw are set. We have made 184 knots from noon yesterday to noon to-day—the best run of the whole voyage. The captain is now shaping his course directly away from the land, or for the middle of Davis Strait, so as to cross the course of the icebergs, which keep its western side, as soon as possible. None, however, were seen. **Good run.**

The remainder of the voyage to England having been on the open sea does not require to be here described. We reached London all well on the 17th of November, or in our tenth week from York Factory, having made one of the most tedious voyages on record. The delay was owing to persistent heavy gales from the south-eastward. The Hudson's Bay Company's ships seldom encounter such weather in their homeward voyages, the length of which average four weeks from York and five from Moose Factory to London, and about one week less to the Land's End. As to the present voyage, I have much pleasure in bearing testimony to the great kindness and constant care displayed both by the captain and his officers, from the time we weighed anchor at York Factory till the ship was safely moored in the West India Docks. **Reach London.** **Average length of voyages.**

General Account of Hudson's Bay.

In the popular mind Hudson's Bay is apt to be associated with the Polar regions; yet no part of it comes within the Arctic Circle, and the latitude of the southern extremity is south of London. Few people have any adequate conception of the extent of this great Canadian sea. Including its southern prolongation, James' Bay, it measures about one thousand miles in length, and is more than six hundred miles in width in its northern part. Its total area is in the neighborhood of 500,000 square miles, or upwards of half that of the Mediterranean. It is enclosed by the land on all sides, except the north-east, where it communicates by different channels with the outer ocean. The principal or best known of these is Hudson's Strait, which is **Great size of Hudson's Bay.** **Hudson's Strait.**

about 500 miles in length, and has an average width of about 100 miles.

Basin of Hudson's Bay.

Hudson's Bay, which might have been more appropriately called Hudson's Sea, is the central basin of the drainage of North America. The limits of this basin extend to the centre of the Labrador peninsula, or some 500 miles inland on the east side, and to the Rocky Mountains, or a distance of 1,300 miles, on the west. The Winnipeg basin constitutes a sort of outlier of the region more immediately under notice, since the waters drain into it from the north, south, east and west, and discharge themselves by one great trunk, the Nelson River, into Hudson's Bay. The southernmost part of this basin, namely, the source of the Red River, extends down nearly to latitude 45°. The head waters of the southern rivers of James' Bay are not far to the north of Lake Huron, while one of the branches of the Albany rises within twenty-five miles of the north shore of Lake Superior. Including the Winnipeg system, the basin of Hudson's Bay has a width of about 2,100 miles from east to west, and a length of about 1,500 miles from north to south, and its dimensions approach the enormous area of 3,000,000 of square miles. Over a great part of this region there is a temperate climate, and although the soil of much of it is comparatively barren, yet large tracts are very fertile. The numerous rivers and lakes of the first class, embraced within these limits, will prove of great value in the settlement of the country. Both the bay and strait are remarkably free from rocks and shoals, which might interfere with their free navigation. The groups of islands near the east side of the bay are surrounded by deep water, and a wide channel leads up the centre of James' Bay. Fortunately the main body of the great bay, which is the portion which may hereafter be frequented by shipping, is entirely without shoals, reefs or islands. The depth is very uniform over most of the bay, and nowhere does it present any great irregularities. It averages about seventy fathoms throughout, deepening to one hundred and upwards in approaching the outlet of Hudson's Strait; while in the strait itself the soundings along the centre vary from about 100 to upwards of 300 fathoms. The bottom appears to consist almost everywhere of boulder clay and mud. Near the shores a stiff clay, affording good holding ground for anchors, is almost invariably met with on both sides.

Dimensions of basin.

Fertile land.

Freedom from obstructions.

Uniform depth.

James' Bay.

James' Bay begins at Cape Jones, on the east side, and Cape Henrietta Maria on the west, and runs south about 350 miles, with an average breadth of about 150 miles. The east side of Hudson's Bay, including its southern prolongation is known as the Eastmain Coast. Between Cape Jones and Cape Dufferin, on the Portland promontory, and again in approaching Cape Wolstenholme, at the termination of

this coast, the land is high and bold, some points attaining an elevation of nearly 2,000 feet above the sea. The country on the south-west side of the main bay, as well as that lying to the west of James' Bay, is low and generally level, with shallow water extending a long distance out from shore. Both sides of Hudson's Strait are high and rocky, but the northern is less precipitous than the southern. **High land.**

Of the numerous rivers which run into Hudson's Bay from all sides, about thirty are of considerable magnitude. All those which enter on the Eastmain coast appear to flow in a uniform course directly west, or parallel to one another, and as the height of land in the centre of the Labrador peninsula is furthest inland towards the south, the rivers which fall into the southern part of this coast are the largest, and the remainder become progressively smaller as we go north. Numerous streams converge to the head of James' Bay from all points southward of an east and west line passing through its southern extremity. The Moose, about a mile wide, is the principal of these. On the western side, the Albany and the Churchill Rivers are the longest, but the Nelson, with a course of only about 400 miles, discharges the greatest body of water into the sea. Indeed this huge artery of the Winnipeg system of waters may be considered as one of the greatest rivers of the world. Few of the rivers of Hudson's Bay afford uninterrupted navigation for large vessels to any great distance from the coast. During the season of high water shallow-draft steamers might ascend the Moose and two of its branches for upwards of 100 miles. Hayes River and two of its branches might also apparently be navigated by such craft in the spring to points about 140 miles inland, and the Albany for nearly 250 miles; while larger steamers might ascend the Nelson for seventy or eighty miles from the open sea. The Nelson is the only muddy-water river entering Hudson's Bay. Most of the others have a slightly brownish tinge, but their waters are perfectly wholesome, and contain only very small quantities of foreign matter. The Churchill, which is the second largest river of Hudson's Bay, is a beautiful clear-water stream, somewhat larger than the Rhine. It is remarkable for having at its mouth a splendid harbour, with deep water and every natural advantage for the purpose of modern commerce. **Thirty rivers.** **Large rivers.** **Navigation of rivers.** **Good water.** **Splendid harbor.**

The only harbors on the west side of Hudson's Bay are those formed by the mouths of rivers, but none of them, with the exception of Churchill Harbor, can be entered by vessels drawing more than ten or eleven feet, and only at high water even by these. The Nelson may form an exception to this. Most of its estuary becomes dry at low tide, but a channel runs through it near the centre, as far as the head of tide-water. I sounded this channel in a number of places. in 1878, '79 and '80, and although an average depth of about two fathoms at low **Estuary of the Nelson River.**

water was found, continuous soundings throughout might have shown interruptions or shallower water in some places. As stated in previous reports, there is a section at the head of tide, or between the tidal portion and the regular inland channel of the river, in which not more than ten feet of water was found. This may extend for about two miles, above which an apparent continuous channel, with a depth of about twenty feet, according to our soundings, extends to the lowest limestone rapid, which is the first break in the navigable part, and is between forty and fifty miles from the head of tide, or from seventy to eighty from the open sea. If the section referred to were deepened, steamers coming in from sea might enter this part of the river and find perfect shelter, or even proceed up the stream to any point below the rapid referred to. In continuation of the channel running down the estuary, a "lead" of deeper water extends out into the bay, and forms the "North River," or "York Roads," with excellent anchorage.

Navigable stretch of river.

Mouth of the Churchill River.

The Churchill, unlike all the other rivers, has a deep, rocky and comparatively narrow mouth, which can be entered with ease and safety by the largest ships at all stages of the tide. On the point at the west side of the entrance of the harbor stands the old "Fort Prince of Wales," which is probably the largest ruin in North America. Although occupying a commanding position, and mounting about forty large guns, it was surrendered, without firing a shot, to the French Admiral, La Perouse, who destroyed it in 1772. The ruins of this large fort are shown in the accompanying wood-cuts, taken from photographs.

Fort Prince of Wales.

Tides.

Along the west coast the rise and fall at spring tides amounts to about eleven or twelve feet, on an average, and is pretty uniform, diminishing somewhat towards the south. It is greatest at the mouth of the Nelson River, where it amounts to about fifteen feet. The tides are lower all along the east side of the bay. In Hudson's Strait there is a very good tide, according to the report we have received of Acting Staff-Commander J. G. Boulton's *reconnaissance* during the past summer.

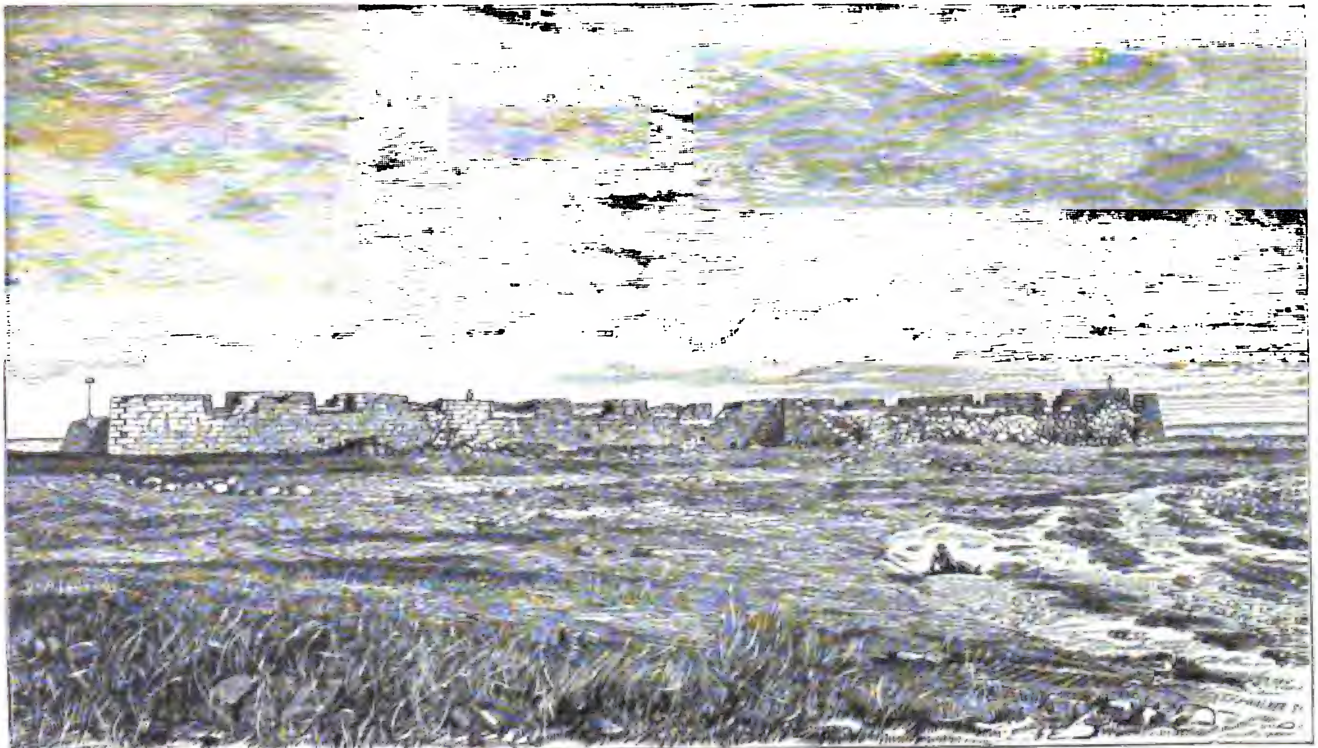
Geology.

Geologically, the basin of Hudson's Bay, excluding the western or Winnipeg division, lies within the great Laurentian area of the Dominion. Cambro-silurian rocks, resting almost horizontally upon these, form an irregular border along the south-western side of the bay; and in the valleys of some of the rivers they extend inland from one to two hundred miles. To the south and west of James' Bay the cambro-silurian are overlaid by Devonian rocks, which here occupy a considerable area. The long chains of islands which fringe the east coast for nearly 300 miles to the northward of Cape Jones, and also the mainland in the vicinity of Richmond Gulf, are composed of bedded-volcanic and almost unaltered sedimentary rocks, resembling the Nipigon series of the Lake

Nipigon series.

From a Photograph by DR. BELL.

RUINS OF FORT PRINCE OF WALES, LOOKING N. E.—CHURCHILL RIVER.



GEOLOGICAL SURVEY, 1880. From a Photograph by DR. BELL.

RUINS OF FORT PRINCE OF WALES, FROM THE WEST.—CHURCHILL RIVER.

Superior region, which may be of Lower Cambrian age. On the western side of the bay, from Churchill northward, quartzites and other rocks, which may also belong to the Cambrian system, appear to be largely developed. Valuable minerals may be looked for on this coast. The extensive level region around the south-western side of the bay, is overspread with a great sheet of boulder clay, which is generally covered by the modified drift. The rocks of the outlying or Winnipeg division of the basin comprise an extensive series, ranging from the Laurentian to the Tertiary. **Level region.**

The resources of Hudson's Bay and the country immediately around it are varied and numerous, although, as yet, few of them are at all developed. The fur trade is the principal and best known business which has hitherto been carried on in these regions; but a considerable amount of oil, derived from the larger whales, the porpoises, walruses, white bears, and various species of seals which frequent the northern parts of the bay, has been carried to New England, and small quantities, principally of porpoise and seal oil, have from time to time been taken to London by the Hudson's Bay Company. The trade in oil might be greatly extended in these quarters. Other articles have been exported from the bay, but hitherto only in trifling quantities. They embrace whalebone, feathers, quills, castoreum, lead ore, sawn lumber, ivory, tallow, isinglass, and skins of seals and porpoises. The fisheries, properly speaking, of Hudson's Bay, have not been investigated. Both the Indians and Eskimo find a variety of fish for their own use, and fine salmon abound in the rivers of Hudson's Strait. From one or two of them a considerable number of barrels, in a salted condition, are exported every year by the Hudson's Bay Company. Water-fowl are very numerous on both sides of the bay, and larger game on the barren grounds in the northern parts; so that the natives, with prudence, may always have a plentiful supply of food. **Various resources.** **Exports.** **Fisheries.** **Game.**

But perhaps the most important of the undeveloped resources of the country around the bay are its soil, timber and minerals. To the south and south-west of James' Bay, in the latitude of Devonshire and Cornwall, there is a large tract in which much of the land is good, and the climate sufficiently favorable for the successful prosecution of stock and dairy farming. A strip of country along the east side of James' Bay may also prove available for these purposes. To the south-west of the wide part of the bay the country is well wooded, and, although little or no rock comes to the surface over an immense area, still neither the soil nor the climate are suitable for carrying on agriculture as a principal occupation until we have passed over more than half the distance to Lake Winnipeg. This region, however, appears to offer no engineering difficulties to the construction of a railway from the sea-coast **Soil, timber and minerals.**

to the better country beyond, and this, at present, is the most important point in regard to it. Some of the timber found in the country which sends its waters into James' Bay may prove to be of value for export. Among the kinds which it produces may be mentioned white, red and pitch pine, black and white spruce, balsam, larch, white cedar and white birch. The numerous rivers which converge towards the head of James' Bay offer facilities for "driving" timber to points at which it may be shipped by sea-going vessels.

Minerals.

Minerals may, however, become in future the greatest of the resources of the shores of Hudson's Bay. Little direct search has as yet been made for the valuable minerals of these regions. In 1875 I found a large deposit of rich ironstone on the Mattagami River. (See Geol. Survey Reports for that year.) In 1877 inexhaustible supplies of good manganiferous iron ore were discovered on the islands near the Eastmain coast, and promising quantities of galena around Richmond Gulf and also near Little Whale River, where a small amount had previously been known to exist. Traces of gold, silver, molybdenum and copper were likewise noted on the Eastmain coast. Lignite was met with on the Missinaibi, gypsum on the Moose, and petroleum-bearing limestone on the Abittibi River. Small quantities of anthracite and various ornamental stones, and some rare minerals, were collected in the course of our explorations around the bay. Soapstone is abundant not far from Mosquito Bay on the east side, and iron pyrites between Churchill and Marble Island on the west. Good building stones, clays and limestones exist on both sides of the bay. A cargo of mica is said to have been taken from Chesterfield Inlet to New York, and valuable deposits of plumbago are reported to occur on the north side of Hudson's Strait. Some capitalists have applied to the Government for mining rights in the latter region.

Saving in distance.

Situated in the heart of North America, and possessing a sea-port in the very centre of the continent, 1,500 miles nearer than Quebec to the fertile lands of the North-west territories, Hudson's Bay now begins to possess a new interest, not only to Canadians, but also to the people of Great Britain, from the fact that the future highway between the great North-west of the Dominion and Europe may pass through it. The possibility of this route being adopted for trade is not a new idea. It has been frequently suggested by far-seeing men in past years, and occasionally referred to in the newspapers. In 1848, the then Lieut. M. H. Synge, in his work on Canada, wrote: "A ship annually arrives at Fort York for the service of the Hudson's Bay Company; who can tell how many may eventually do so?" The journal of the Statistical Society of London for March, 1864, contains a paper by H. Y. Hind on "The Commercial Progress and Ressources of Central British America,"

Route for trade

in which the writer says: "It is more than probable that whenever the necessity arises, the communication between Winnipeg and Hudson's Bay, and thence to the Atlantic, by the aid of steamers, will be made easy and speedy for at least three months in the year." In 1876 Mr. Selwyn brought the subject officially before members of the Canadian Government, and recommended that surveys be made of Hudson's Bay and Strait. In 1878 Col. Dennis published a pamphlet, accompanied by a valuable map, in relation to it. The report of the Minister of the Interior for 1878 contains an appendix by the writer on the practicability of building a railway from Lake Winnipeg to Hudson's Bay. During the session of 1878–79, and again the following year, the Hon. Thomas Ryan, a gentleman of great enterprise, brought the matter under the notice of the Dominion Senate.

Chartered companies.

In 1880 the Parliament of Canada granted charters to two companies for constructing railways and otherwise opening a route for commerce from the North-west territories to Europe, *via* Hudson's Bay, and during the past year one of them, the Nelson Valley Company, caused a survey to be made of a part of the distance betweeen Lake Winnipeg and the harbor of Churchill. Their chief engineer has reported the route, as far as he located the line, to be an easy and inexpensive one for a railway. The directors of the company have again sent an engineering party to the field to carry on the survey during the present year (1881). This company has also the power of connecting with the Canadian Pacific railway in the Saskatchewan region, but the main line is intended to form a connecting link between the great system of inland navigation, which centres in Lake Winnipeg, and the sea. If constructed, the Nelson Valley railway may carry to the sea-board not only the surplus of the grain and cattle of our own North-west, but also that of Minnesota and Dakota. Lieut.-General Sir J. H. Lefroy, President of the Geographical Section of the British Association, in his address at the Swansea meeting (1880), said: "Hudson's Bay itself cannot fail, at no distant day, to challenge more attention. Dr. Bell reports that the land is rising at the rate of five to ten feet in a century, that is, possibly, an inch a year. Not, however, on this account will the hydrographer notice it; but because the natural sea-ports of that vast interior, now thrown open to settlement, Keewatin, Manitoba, and other provinces unborn, must be sought there. York Factory, which is nearer Liverpool than New York, has been happily called by Professor H. Y. Hind, the Archangel of the West. The mouth of the Churchill, however, although somewhat further north, offers far superior natural advantages, and may more fitly challenge the title. It will undoubtedly be the future shipping port for the agricutural products of the vast North-west territory, and the route by which immigrants will

Engineer's report. Link of railway. Genl. Lefroy's remarks.

enter the country." Sir Henry Lefroy, being personally well acquainted with Hudson's Bay and the North-west territories, may be accepted as a good authority on the subject.

Great wheat-growing region.

It has been shown that the Canadian North-west territories, embracing hundreds of millions of acres of fine land, are destined to become the greatest wheat-field in the world. The centre of this immense agricultural region probably lies to the north of the Saskatchewan. If we look at the map of the northern hemisphere, we shall see at a glance that the shortest route between these territories and England is through Hudson's Bay. Mr. Lindsay Russell, the Surveyor-General, has recently made a close calculation of relative distances, and foundthat even the city of Winnipeg, which is situated in the extreme south-eastern part of these territories, is at least 800 miles nearer to Liverpool by the Hudson's Bay route than by the St. Lawrence; while the difference in favor of the former will be increased continually as we advance north-westward into the interior. If we take a central point of the whole of the agricultural lands of our North-west territories, say in the neighborhood of Lac la Biche, Long. 112° W., Lat. 55° N., we shall find that the distance from it to the city of Winnipeg is about the same as to Churchill, on Hudson's Bay. The distance from the latter point to Liverpool is about the same as from Montreal to this port; so that between the above-named centre and Liverpool, by the Hudson's Bay route, the whole distance from Winnipeg to Montreal is saved. This amounts to 1,291 miles by way of Lake Superior, and 1,698 miles by the Chicago route. The distance by way of New York is still greater than by Montreal. The advantages of this route over all others are numerous, and a few of them may be here referred to. The great saving in distance represents an important economy in time and money, or in freight and passenger rates. If the grain, cattle and other products of the North-west territories could reach a European market only through Ontario and Quebec, or by way of New York, a large proportion of their value would necessarily be consumed by the long land carriage; whereas, if they can find an outlet at Churchill or York Factory, there will be a saving of at least 1,291 miles as compared with Montreal, and of upwards of 1,700 miles as compared with New York, and this without increasing the length of the voyage. In effect, this will place a great proportion of the farms of our North-west territories in as good a position with regard to a seaport as are those of Ontario west of Toronto, and consequently will greatly increase the value of every description of farm produce, and therefore of the farms themselves. Some kinds of produce which could not be sent out of the country at all by the longer land routes may be profitably exported by the shorter one. Owing to the short land journey, grain from the Saskatchewan and Peace River regions could be

Shortest route.

Centre of agricultural region.

Advantages of northern route.

Comparison with Ontario.

exported by way of Hudson's Bay the same year in which it is harvested, which could scarcely be hoped for if sent by way of one of the longer routes. For the transportation of both grain and fresh meat, as Col. Dennis has pointed out, the northern route, besides the shortening of the distance, would have great advantages over all those to the south, owing to its cooler and more uniform temperature. Heavy or bulky goods of all kinds would of course be imported into the North-west territory by the shortest land route. In regard to the export or import of live stock, this independent route will possess a great importance to these territories. Hitherto, cattle, horses, hogs and sheep have there enjoyed an immunity from almost all forms of contagious diseases, and owing to the very healthy nature of the climate for these animals, it is hoped this state of things will continue. The domestic amimals in the United States and the older Canadian Provinces being occasionally afflicted with contagious disorders, it becomes necessary for European countries to impose restrictions on their importation. In the event of an epidemic of this nature existing in some part of these regions, but not in the North-west territory, there would be no objection to exporting live stock from the latter by way of Hudson's Bay.

Col. Dennis' observations.

Export of live stock.

As a route for emigrants from Europe, that by Hudson's Bay possesses not only the advantages of the short land journey, but the still more important one, to us, of entirely avoiding the United States and the populous parts of Canada, in both of which, it is well known, a very serious percentage of the immigrants destined for our North-west lands are every year enticed away to settle in the great republic. An inlet by Hudson's Bay is the only thoroughly independent channel which can ever be established between Great Britain and the great and valuable British territories in the interior of North America; and it is very desirable, on national grounds, that this route should be opened up. Troops have hitherto been sent to the Red River settlement, on more than one occasion, by way of Hudson's Bay, while the intervening country was, as it is yet, in a state of nature. Were a short railway built through this tract, it would at once become for military purposes an easy connecting link with the Mother Country.

Route for emigrants.

Independent channel.

An impression has long prevailed that Hudson's Bay and Strait could not be navigated for the ordinary purposes of commerce, on account of ice, but this idea is perhaps destined to prove chimerical. The occasion for testing the point had not hitherto arisen, and the fact that these waters have been successfully navigated by ordinary sailing vessels for nearly 200 years, in order to secure what little trade the country has hitherto afforded, indicates what may be expected from properly equipped steamships, as soon as the larger business of the future may require their services in this direction. The conditions of

Successful navigation of Hudson's Bay.

Comparison with Gulf of St. Lawrence.

the sea-borne commerce of the North-west in relation to Hudson's Bay may, after all, turn out to be somewhat similar to those of the rest of Canada with reference to the Gulf of St. Lawrence. In both cases, everything must be done during the summer. Yet, Hudson's Bay is, of course, open all the year round. A sea of such vast extent in the latitude of the British Islands would not be expected to freeze across, and as a matter of fact it does not. The Lower St. Lawrence (notwithstanding its comparative narrowness) is also partly open, even in the middle of winter. But the difficulty in both cases is the apparent impossibility of getting into harbors. A harbor such as that of Churchill on Hudson's Bay would have the advantage over Quebec or Montreal of connecting directly with the open sea, and hence in the autumn vessels would not be liable to be frozen in, as occasionally happens in the St. Lawrence, as for example in the autumn just passed, also in the autumn of 1870, when the outward bound shipping got frozen in below Quebec, occasioning a loss, it was said, of over a million of dollars. Again, in the spring there might be no more uncertainty about entering from sea than in the Gulf of St. Lawrence, where vexatious delays are not uncommon after the open season is supposed to have arrived.

Open water.

Some discussion has taken place in the newspapers as to the length of time during which Hudson's Strait and Bay might be navigated each year, but there does not seem to be much evidence that the strait is entirely closed at any season, and the bay is always open. The great width and depth of the strait, and the strength of its tides, probably keep it open all winter. My own experience and that of many others leads me to believe that the climate generally of Hudson's Bay is much better than is popularly supposed. From all that I could learn or observe, there appears reason to believe that the strait and bay may be navigated and the land approached *by steamships* during an average of over four months each year, or from the middle of June till near the end of October. The strait and bay might perhaps be navigated by steam vessels earlier than the middle of June, but nothing would be gained, except perhaps by whalers, in going out before an open harbor could be reached. Much has been recorded in favor of the above opinion, from the days of the Danish Captain, John Monck, who wintered at Churchill 261 years ago (1619-20), to the present time, and a good deal of unrecorded evidence which I have collected leads me to the same conclusion. Churchill Harbor does not freeze up until November, and the sea is open close to it during the whole winter.

Season of navigation.

Climate of Martin's Falls.

A record of the principal phenomena of the seasons at Martin's Falls, on the Albany, extending through a period of fifty years, shows that the river there is open on an average for fully six months of the year. In the Appendix will be found a record of the opening and closing of

Hayes River at York Factory for fifty-two years, which proves it to have an annual average of six months of open water. The Nelson is open for a longer period, which may amount to an average of seven months, but no exact record has been kept in regard to this stream. The tidal portion is said never to set fast, but in winter more or less ice drifts up and down with nearly every tide, the channel out to sea being clear only after the prevalence of strong winds off the land. During the winter of 1880-81 the river did not freeze across at all for some forty miles above tide water. Hayes River open six months.

In view of such facts as the foregoing, the navigation of Hudson's Bay and the approach to land by steamships need not be despaired of, as far as the length of season is concerned. Even were the time of open navigation shorter than it is known to be, the very great benefits which Canada generally, and the North-west territories in particular, would derive from possessing an outlet in that direction are sufficient to make it well worth an effort to open it up. The freedom of Hudson's Strait and Bay from rocks, shoals and other impediments to navigation will exempt vessels in that quarter of the globe from the heavy expenses for pilots, lighthouses, &c., which burden shipping to many other American ports. The delays from drifting ice in the strait which have heretofore occasionally occurred to sailing ships, especially of the old-fashioned type, cannot be fairly cited at all as to what may be expected to be accomplished by well appointed steam vessels. Importance of short route. Experience of sailing ships not applicable to steamers.

Both shores of Hudson's Strait are high and bold, and if observatory stations were placed upon some of the more elevated points on either side they would command a complete view of its entire surface. By means of signals or telegraphic communication between these stations, in case of the existence of drifting ice, vessels could be directed what course to follow in order to pass through it at the easiest part or to avoid it altogether. Bold shores of Hudson's Strait Signals.

It is evident that in proportion as the cost of transporting farm produce to a foreign market is diminished its home value is correspondingly increased, and with it the value of the land itself, in about the same ratio. Now, considering the vast extent of the farming lands to be favorably affected by the opening of the route above referred to, if the value of each acre of it were enhanced in this way by only seventy or eighty cents, the aggregate increase would amount to more than a hundred million of dollars. Such a gain as this, together with the great advantages which, as we have seen, may be derived from the opening of this new ocean route, should it prove feasible, will, I think, sufficiently show the importance of at least giving it due consideration. Increased value of land.

I am indebted to William Armit, Esq., the obliging Secretary of the Hudson's Bay Company in London, for the list in the Appendix show-

Arrivals and sailings of ships at York and Moose Factories.

ing the dates of the arrivals of the Company's ships at Moose Factory, and of their departure from that point, and to Mr. Chief Factor Fortescue for the similar list in reference to York Factory. They show that very few interruptions have occurred in making the regular annual voyages to these ports during periods of 147 and 93 years respectively.

THE NORTHERN LIMITS OF THE PRINCIPAL FOREST TREES OF CANADA, EAST OF THE ROCKY MOUNTAINS.

Authorities for tree-lines.

Far North-west

Botanists.

Geologists.

Capt. Kennedy.

Labrador.

Lake Superior.

On the accompanying map the general northern limits of the principal forest trees of Canada, east of the Rocky Mountains, are represented. The lines have been laid down chiefly from observations made by the writer during the last twenty-five years, extending from Newfoundland nearly to the Rocky Mountains, and from the northern United States to the eastern and western shores of Hudson's Bay. The limiting lines of the species which extend into the far North-west are drawn from information received from various officers of the Hudson's Bay Company, and from the data furnished by the accounts and maps of the different scientific travellers who have penetrated these regions. In the more southern regions, many details have been obtained from lumbermen and botanists which have helped to determine the lines with great accuracy in certain localities. Among the botanists may be mentioned Mr. A. T. Drummond, the late Dr. John Bell, Professors Lawson, Bailey, Macoun and N. H. Winchell, also the older botanists who have written on our flora. Thanks are due to my colleagues on the Geological Survey, Messrs. Richardson and Webster, for some facts on the distribution of trees in the Province of Quebec, and to Messrs. Fletcher, Ells and Broad, for others as to the Maritime Provinces, while Mr. A. S. Cochrane has made careful notes on this subject during our explorations in the North-west territories. To Captain William Kennedy, the Arctic explorer, now residing in Manitoba, thanks are due for valuable information as to the trees of the peninsula of Labrador, in different parts of which he spent a number of years in the service of the Hudson's Bay Company. The Hon. D. A. Smith, Mr. Robert Crawford, and others who have resided in the Labrador country, have also given notes on the timber, which have greatly facilitated the approximate determination of the limits of the species found in that large peninsula. Nearly all the reports of the Geological Survey, from 1857 to 1879, contain more or less information on the distribution of timber trees, but previous to the former year the writer had studied the forests of southern Ontario and the Ottawa valley. In a paper on the "Trees and Shrubs of Lake Superior," published in the Transactions of the Botanical Society of Canada in 1861, he pointed out a number of facts in regard to the geographical distribution of trees in

that region, which had not been previously observed. In 1873, the northern limits of our principal timber trees in the provinces of Ontario, Quebec, New Brunswick and Nova Scotia were laid down in colored lines on a large sheet, to illustrate a lecture before the Natural History Society of Montreal, by Mr. A. T. Drummond, on the distribution of plants in Canada. This sheet was loaned to the Department of the Interior, Ottawa, and some of the lines were transferred from it to the large map exhibited by the Department at the Paris International Exhibition of 1878. A reduction of the same sheet was published in 1879, to accompany a paper by Mr. Drummond in the report of the Montreal Horticultural Society and Fruit-Growers' Association. In the portion of the present map which includes the four provinces referred to, the tree-lines are all carefully revised and corrected. The northern limits of thirty of the principal species of our forest trees are outlined on this map, being as large a number as can be conveniently represented on so small a scale. About forty other species, however, besides shrubs, occur within the limits of the Dominion east of the Rocky Mountains. A list of these, with notes on their geographical distribution, is added to that of the species mentioned on the map. **Original map.** **Thirty species shewn on map.** **Forty other species east of the Rocky Mts.**

One of the principal uses of this map is to indicate the area within the Dominion throughout which each kind of timber exists. The abundance and quality of each kind varies much, of course, within these boundaries. Occasional or chance trees and depauperated representatives of some of the species shown on the map are known to occur beyond the limits laid down, but as these lines are intended to represent the general boundaries, they could not fairly be extended so as to include such cases. More or less extensive outliers or colonies of some trees occur in situations entirely separated from the main areas occupied by the species to which they belong. The southern boundaries of some of the more northern species, such as the white spruce, Banksian pine and balsam poplar, might be nearly included within the map, but to avoid confusion it is considered best to show only the northern limits. Most of our forest trees extend far to the south of the confines of Canada, so that at any point which we choose to select within the Dominion we are apt to find in the forest nearly all the species whose northern limits lie to the north of it. Professor Charles S. Sargent, of Harvard College, a special commissioner in connection with the tenth census of the United States, is preparing maps illustrative of the distribution of the woods, prairies and barren grounds of North America, and at his request the writer has had much pleasure in assisting him in this work as far as Canada is concerned. **Occasional occurrence beyond limits.** **Southern boundaries.** **Prof. Sargent.**

A knowledge of the limits of our different forest trees is also valuable as indicative of climate. Some of these will be found to correspond **Other practical value of this information.**

with the northern limits of the successful cultivation of particular crops. Certain trees cease to exist when they come to regions subject to severe spring or summer frosts, or where early autumn frosts prevent them from maturing their fruits. Locally, the presence of a particular group of trees is serviceable as a guide to the quality of the soil, but owing to differences in the character of the climate and other circumstances, it is obvious that such a test, although quite reliable within a limited area, may not be at all applicable to another region.

Situation and latitude.

Some species appear to find their appropriate conditions in different latitudes by a change in their habitat: for example, the larch, balsam fir and white birch, which in the north grow freely on dry or hilly ground, towards the southern limits seek the cold ground in swamps. The white cedar and white pine in some places manifest the same tendency.

Effect of mountains.

The appropriate temperature for the growth of a number of species is carried far to the south of their normal latitudes, along the elevated parts of the continent, especially the Alleghanies and the Rocky Mountains.

Causes governing range of species.

The range of any species is evidently not governed entirely by the mean annual temperature. The extremes of heat and cold in the west, as compared with the milder winters and cooler summers in the east, with about the same mean temperature for the year, appears to be the chief cause of the marked difference in the character of the woods in the two regions, since there is not a sufficient disparity in the amount of the annual precipitation to account for it. A great difference in the moisture of the air in two regions, otherwise resembling each other in climatic conditions, has also a powerful effect upon the growth of forests; and the dryness of the air in the western prairie and arid regions is, no doubt, the chief cause of the absence of timber. The proximity of the sea, especially where fogs or cold winds are of frequent occurrence, has a great influence upon the kinds and the size of the timber, and, in the north, upon the very existence of trees near the coast. Differences in the composition of the soil appear to have only a local effect upon the distribution of forest trees.

Geological interest.

The study of the geographical distribution of the various forest trees of North America possesses a certain interest to the geologist as bearing upon questions in regard to the condition of the continent in later geological times. The outlines of the areas occupied by the different species, and other circumstances connected with their character and distribution, may throw some light on their dispersion from certain centres or lines, or possibly, in some cases, their contraction from wider limits; or we may find that some of them have still a tendency to advance or retire.

The continent of North America possesses a great variety of forest trees. About 340 different species occur within the United States. All the kinds which we have in Canada, amounting to about ninety, including those of the Pacific slope, are also met with in that country. Some species are not only very widely diffused, but are also persistent over great areas, being found almost everywhere within the limits of their distribution, while others, although having an extensive range, are nowhere very common, and are sometimes absent for considerable intervals. Others, again, are confined to comparatively small tracts. As a general rule, the more northern species occupy the greatest extent of country, while the southern ones are progressively more and more restricted, even in a more rapid ratio than would be implied by the narrowing of the continent from north to south. This is owing to the great differences experienced in climatic conditions in going from east to west in the more southern latitudes. Along the northern borders of the forests of the continent the elevation of the land above the sea is comparatively slight and regular, and the other physical conditions are tolerably uniform. As a consequence, we find the most northern group of trees extending from Newfoundland into Alaska, a distance of about 4,000 miles.

Great variety of trees in North America.

Great areas occupied by northern species.

Causes.

An inspection of the accompanying map will show some interesting features as to the general distribution of our forest trees, as well as regarding almost every individual species of timber. For example, it will be observed that there is no material change in the woods throughout the great triangular area embracing about 600,000 square miles, of which the national boundary line between the Rocky Mountains and Lake Superior forms the base, and the Rocky Mountains and Laurentian hills respectively the west and east sides, the apex being at the mouth of the Mackenzie River. In the southern part of this area, a number of species are added to the kinds which everywhere throughout it make up the bulk of the forests, and again, few trees of any kind are found to the south of the North Saskatchewan; still, making allowance for local peculiarities of condition, there is a remarkable uniformity in the timber of this enormous area. It includes, however, only a few species, of which the aspen, balsam poplar and willows are more abundant towards the western, and the spruces, larch, balsam fir and Banksian pine towards the eastern side of the area.

Peculiarities.

It will be observed that the lines marking the northern limits of about a dozen species turn southward and become their western limits on reaching the eastern side of the valley of Lake Winnipeg and the Red River; while the boundaries of the species occurring next to the south of these also manifest a tendency to turn southward in approaching the prairies of the west. The species above referred to are the

Limiting lines turn southward towards Red River.

white cedar, black ash, white pine, red pine, sugar maple, yellow birch, red oak, white ash, hemlock, beech, ironwood, red cedar (arborescent variety) and white oak. They are to a great extent replaced by other species before the region of open plains is reached. Had the great forests originally extended further west, and been destroyed by fire or other causes, in comparatively recent times, we should have found the northern limits of these species continuing their general course to the prairie region, and ending abruptly there, instead of which they all curve gradually round, in a more or less concentric fashion, and other trees occupy the intervening ground. These well-marked features of forest distribution show that the present divisions of prairie and woodland are of very ancient date. The evidence of the smaller plants, and also of certain superficial geological conditions, all point to the same conclusion.

Replaced by western species.

The state of Minnesota is situated in a very interesting region in regard to forest distribution. Here we find the northern limit of the group to which the most southern trees of Ontario belong, such as the black walnut, shell-bark hickory, hackberry and Kentucky coffee tree; the north-western limit of the commoner trees of the northern states and of Quebec and Ontario, such as the white oak, red cedar (aborescent variety), ironwood, beech, hemlock, white ash, rock elm, red oak, yellow and black birch, sugar maple, red maple, wild plum, &c.; the western boundaries of some of the trees whose northern limits pass through northern Ontario, such as the white cedar, black ash, white pine and red pine; the southern limits of the most northern group, including the white spruce, the larch, Banksian pine, balsam fir, balsam poplar and canoe birch; and the general eastern limits of some of the western species, such as the ash-leaved maple, green ash, bur oak and cottonwood.

Forest distribution in Minnesota.

It will be observed that in the Labrador peninsula the tree-lines trend northward mid-way between the eastern and western shores. This is due partly to the unfavorable influence of the sea on either side, and partly to the beneficial effect of the central depressions in which the rivers run northward into Ungava Bay. From Mingan to Lake Superior, the height of land, north of the St. Lawrence, is rudely parallel to the general course of the lines marking the northern boundaries of the trees, and it may have had some effect in limiting the northward range of a number of species. A southward curve in the watershed about the longitude of Ottawa is marked by a corresponding curve in the tree-lines, Again, where a great depression occurs in this dividing plateau, some of the trees, which in such places may be approaching their northern boundaries, are found to extend, in the lower levels, beyond their general outline on either side. As examples

Trend of tree-lines in Labrador.

Height of land parallel to tree-lines.

Effect of depressions.

of this, the Lake Temiscaming and Abittibi district, and the valley of the Kenogami, or principal south branch of the Albany, may be mentioned. On the Missinaibi, or west branch of the Moose River, the white elm reappears 130 miles north of its general boundary on descending to a sufficiently low elevation above the sea. The Saguenay, for about 100 miles from the St. Lawrence, is really a narrow arm of the sea, and the country in the vicinity of Lake St. John, at the head of the river, is only slightly elevated above its level, and has a fertile soil, although surrounded by a mountainous region. Here we find an isolated colony of bass-wood, sugar maple, and other trees, considerably removed from the rest of their species. On the north side of Lake Huron and to the north of the city of Quebec, the land rises somewhat rapidly, and in both instances the tree-lines near these latitudes are more closely crowded together than elsewhere.

Moose River. **Lake St. John.**

Approaching northern limits. Some kinds of trees, in approaching their northern limits, show a tendency to diminish gradually in size, and to become more and more scattered, rendering it difficult to draw any definite boundary of the species, while others vanish abruptly. The latter habit is more characteristic of southern than northern species, as far as the Dominion is concerned. The various species appear to die out more gradually as they range northward in the western than in the eastern regions.

Four groups. Forest trees east of the Rocky Mountains may be divided into four groups, as regards their geological distribution within the Dominion: (1) A northern group, including the white and black spruces, larch, Banksian pine, balsam fir, aspen, balsam poplar, canoe birch, willows and alder. These cover the vast territory down to about the line of the white pine. (2) A central group of about forty species, occupying the belt of country from the white pine line to that of the button-wood; (3) a southern group, embracing the button-wood, black walnut, the hickories, chestnut, tulip-tree, prickly ash, sour-gum, sassafras and flowering dog-wood, which are found only in a small area in the southern part of Ontario; (4) A western group, consisting of the ash-leaved maple, bur oak, cotton-wood and green ash, which are scattered sparingly over the prairie and wooded regions west of Red River and Lake Winnipeg.

Richness in species. In the western peninsula of Ontario the forests present a remarkable richness in the number of species to be found growing together. In some localities as many as fifty different kinds may be counted on a single farm lot. A more varied mixture is probably not to be met with in any other part of the continent, or perhaps in the world.

In tracing the tree-lines across the continent in the comprehensive manner shown on the map, it will be found that most of them afford interesting peculiarities for study. A few facts will now be given in

Thirty species enumerated in their order from north to south.

regard to the geographical distribution of the thirty species whose northern limits, within the Dominion, are shown upon the map. They will be noticed in the order of their occurrence from north to south, and the lines traced from east to west. The common names used are those by which they are known in Canada.

White spruce.

1. White Spruce, Single Spruce, Sea Spruce—Pine of the Hudson's Bay Company's people,—(*Albies alba*, Michx.)—This and the next are the most northern trees of North America. Abundant and of good size in Newfoundland and the Maritime Provinces, where it is sawn into deals. The Indians of these provinces call it "sea spruce" to distinguish it from the next. Captain Kennedy informs me that south of the limit shown on the map it is common in valleys and sheltered places throughout the Labrador peninsula. It nowhere reaches the Atlantic coast, receding fur ther and further in going north. On the south side of Ungava Bay it is found at the mouths of Whale, George's and Ungava Rivers, large enough for building boats, but the trunks are short and apt to be knotty. In going up the east coast of Hudson's Bay it vanishes about latitude 57°, or a few miles above Richmond Gulf, but it is said to extend further north at a distance inland. On the west coast of the bay it extends to Seal River, in latitude 59°, from which the northward limit runs apparently almost directly north-west to near the mouth of the Mackenzie River, or about latitude 68°. According to both Hearne and Sir John Richardson, it is found on the Coppermine River to within twenty or thirty miles of the sea. Around James' Bay, and between this bay and Lakes Huron, Superior and Winnipeg, it attains a good size for lumber, and even on the Hayes and Nelson Rivers I have seen good, sound logs cut upwards of two feet in diameter, and showing from 100 to 140 lines of growth. Common throughout Quebec and Northern Ontario, but rare in the southern parts of the latter province. In the prairie country I have not seen it further south-west than Pine Creek, about 100 miles west of Winnipeg.

Maritime Provinces.

Labrador.

Hudson's Bay.

Mackenzie River.

Black spruce.

1*a*. Black Spruce, Double Spruce (*Abies nigra*, Poir.)—Professor Gray regards the white and black spruce as probably only varieties of one species, and there certainly appears to be every gradation between the two. The white spruce grows on rich intervale grounds, or near the shores of lakes and rivers; it becomes a moderately large tree, while the black spruce is found on hills and in cold swamps, and is a smaller tree than the other. The bark of the white spruce, when young, is smooth and grey, while that of the black spruce is brownish, and is always covered with small, loose scales, even when the trees are young. The two kinds have the same geographical range northward.

Differences.

American larch.

2. American Larch, Tamarac, Red Spruce, Juniper (*Larix Americana*, Michx.)—All the way from Newfoundland to near the mouth of

the Mackenzie River, the northern limit of this tree is only a little to the southward of that of the spruce. It is found along with this tree on the shores of Ungava Bay. In Newfoundland, New Brunswick and the Gaspé peninsula it attains a good size, and is a valuable timber-tree on all the northern branches of the St. Lawrence and throughout the Ottawa valley, from which large quantities have been exported for ship-building, &c. It has an equally thrifty growth in the country to the south of James' Bay, and westward towards Lake Winnipeg. In this great region it attains its greatest perfection on the dry uplands and in good soil near the rivers, but smaller trees, with small black spruces, grow everywhere on the level or swampy grounds. South of the Ottawa it grows principally on low and level land. **Larch exported.**

3. Balsam Poplar, Balm of Gilead, Rough-Barked Poplar, Cotton Tree, White-Wood, &c., (*Populus balsamifera*, L.)—Abundant everywhere around the Gulf of St. Lawrence and throughout a great part of the Labrador peninsula. Luxuriant, but not of large size, along all the rivers of James' Bay and of the south-west side of Hudson's Bay, disappearing about Fort Churchill, from which its northern limit runs to about latitude 65° on the Mackenzie. On the east side of the bay small trees were seen as far north as Richmond Gulf. It is a very common tree, and of large size in the valley of the Mackenzie, especially on the Rivière aux Liards. It attains a considerable size around Lakes Huron and Superior, where the thick bark of old trees is used by the fishermen as a subsitute for cork in making net-floats. **Balsam poplar.** **Hudson's Bay.** **Mackenzie River.**

4. Aspen, Common Poplar, Trembling-Leaved Poplar (*Populus tremuloides*, Michx.) A rather more southern tree than the last; very common throughout the whole region from the Gulf of St. Lawrence to near the mouth of the Mackenzie River. It extends over the southern half of the Labrador peninsula, and around James' Bay. On the south-west side of Hudson's Bay it keeps some distance back from the coast. It is the commonest tree in the prairie and half-wooded parts of the North-West territories. Throughout the Hudson's Bay Territory it is the principal fuel used by Indians and for open fires at the Company's posts, as it does not throw out sparks like the spruce and larch. In the Eastern Townships and elsewhere it is used for the manufacture of paper. Although the most widely diffused tree of North America, it is relatively most abundant in the west, where it ranges from the Arctic regions to California. Professor Sargent remarks that it has "not yet been seen on the high peaks of the southern Alleghany Mountains, to which it might naturally extend." **Aspen.** **Labrador.** **North-West territories.** **Most widely diffused tree of North America**

5. Canoe Birch, White Birch (*Betula Papyracea*, Ait.)—A very common tree along the northern tributaries of the St. Lawrence, and **Canoe birch.**

Labrador. ranging as far north in the Labrador peninsula as Lake Naskopie, and to within 250 miles, or perhaps less, of Ungava Bay, on the river of the same name. Greatest perfection. It attains its greatest perfection around the Gulf of St. Lawrence and in the Ottawa valley, and is also found of large size near Lakes Huron and Superior. In Labrador, on both sides of James' Bay and north-westward to the Mackenzie River, it affords sufficiently large Canoe building. sheets of bark for canoe-building. From James' Bay to the Mackenzie, which it strikes beyond the Arctic Circle, its northward boundary keeps near that of the aspen, being sometimes on one side of it and sometimes on the other. In the most southern parts of Ontario it is rare, of small size, and found only in swamps. In the Red River region it ranges as far south as the United States' boundary, and is found along the Assiniboine valley as far west as the Qu'Appelle lakes.

Banksian pine. 6. BANKSIAN PINE, SCRUB PINE, JACK PINE, CYPRESS (*Pinus Banksiana*, Lamk.)—This tree has not been noticed in Newfoundland, on the north shore of the Gulf of St. Lawrence, nor in the interior of Labrador beyond Lake Mistassini, although it may possibly have a somewhat more northern range in this peninsula than represented on the map. It occurs throughout Nova Scotia and New Brunswick. Starting from Northern limit. the head of the Bay of Chaleur, its northward limit appears to cross the other tree lines to the lake just named, from which it runs west to the Moose River, keeping about 100 miles south of James' Bay. From Moose River it runs north-west to the Mackenzie, which it crosses about the Arctic Circle. It does not touch either James' or Hudson's Bay. Southward it is common on the north shore of Lake Huron and around both shores of Lake Superior, whence it is met with all through Area of distribution. the country to Lake Winnipeg. The area over which it is distributed appears to be in the form of a belt, with a breadth equal to five or six degrees of latitude, running across the continent. Although a small and scrubby tree in the southern and eastern parts of its range, in the central part (both as regards latitude and longitude) it attains much greater perfection. On the southern branches of the Albany I have seen large groves of these trees about seventy feet in height, and two feet in diameter at the butt, with straight trunks nearly free from branches for the first twenty or thirty feet.

Balsam fir. 7. BALSAM FIR, FIR, VAR, SILVER PINE, BLISTER PINE—"Palm" in Cape Breton—(*Abies balsamea*, Marshall.)—The Maritime Provinces, Newfoundland and the southern half of the Labrador peninsula, its northern limits in this region being on Naskopie Lake and the Ungava Gaspé. River. It flourishes best in the Gaspé peninsula, where I have seen many trees from twenty inches to two feet in diameter, with trunks tall enough to afford one good sawlog—about fifteen feet. It occurs around James' Bay, but its northern limit keeps to the south-west of

Hudson's Bay, where it passes between Fort Severn and Trout Lake, and reaches the neighbourhood of the junction of the Shammattawa and Steel Rivers, which form the Hayes' River. From this point it turns south-west, and crosses the Nelson River at the outlet of Sipiwesk Lake, from which it runs north-west to the Mackenzie River, crossing it about latitude 65°. South-west of Hudson's Bay it grows only in the warmest and best soils, and is entirely wanting in the cold, swampy tracts. In Ontario, where it is cultivated as an ornamental tree, I have not observed it growing naturally south of the latitude of Toronto. In the North-West territories it appears to be absent to the south and west of Lake Winnipegosis. **Nelson River.** **Ontario.**

8. WHITE CEDAR, CEDAR, ARBOR VITÆ (*Thuya occidentalis*, L.)—The geographical distribution of this species presents some very interesting features. In the Gulf of St. Lawrence region its boundary runs south-east from Anticosti to the Bay of Fundy, directly acros sall the intervening tree-lines. It is absent from Newfoundland, Cape Breton, Nova Scotia, and the eastern half of Prince Edward Island, but is unusually large and fine in New Brunswick and the Gaspé peninsula, in which the climate, soil, &c., are the same as in the adjacent regions, where not a trace of the species is to be found. From Anticosti the limit runs south-westward to a point about 200 miles north of Montreal. Thence it turns north-west and reaches Rupert's House, on James' Bay. From the neighbourhood of Moose Factory the line crosses the Albany River at some distance from the sea, and continues westward to a point about seventy-five miles south-west of Trout Lake, where it turns south-west and reaches the southern extremity of Lake Winnipeg; thence it turns southward to the United States boundary, keeping to the east of the Red River all the way. There is a remarkable outlier of white cedar brushwood around Cedar Lake, on the lower part of the Saskatchewan River, at a distance of 190 miles to the north-west of the nearest point of the main area covered by the species, and a few cedar trees are said to occur on Lake Winnipeg, not far from the mouth of the Saskatchewan. Captain Kennedy informs me that he believes the white cedar occurs in Labrador west of the head of Hamilton Inlet. If so, this outlier would occupy a position with regard to the north-east promontory of the cedar-line which would correspond to that of the Cedar Lake one to its north-western promontory. We might account for the singular fact that the white cedar has not yet extended itself eastward into Newfoundland and Nova Scotia by supposing that, in comparatively late geological times, when the land was lower or the sea higher, the Arctic current, which now flows through the Straits of Belleisle into the Gulf, passed on over the isthmus separating Nova Scotia from New Brunswick, and flowed through the Bay of Fundy. This **White cedar.** **Cedar absent.** **James' Bay.** **Lake Winnipeg.** **Outlier.** **Labrador.** **Supposed cause.**

steady current of Arctic water, which would itself carry no seeds of trees, might prevent those of the cedar from crossing to the islands beyond it. But on this hypothesis it would be difficult to understand why the white pine, yellow birch and other trees, which are even more southern in their general habit than the species in question, should be found in these provinces.

Difficulty.

Black ash.

9. BLACK ASH, SWAMP ASH (*Fraxinus sambucifolia*, Lam.)—In Anticosti and southern Newfoundland. From the neighbourhood of Seven Islands the northern limit runs west (curving slightly to the southward) to Lake Winnipeg. It is common, but of small size, along the different branches of the Moose River, especially towards the height of land. St. Peter's portage, on the Missinaibi branch is the most northern point at which I have seen it in this region. I have found small trees around the southern part of Lake Winnipeg, but have never noticed it further west.

Moose River.

White elm.

10. WHITE ELM, SWAMP ELM, GREY ELM, AMERICAN ELM (*Ulmus Americana*, Willd.)—With the exception of the northern group, this species has the widest range of any tree in Canada. It extends from the southern part of Newfoundland to the base of the Rocky Mountains. It occurs at the head waters of all the principal branches of the Moose River, and on one of them, the Missinaibi, I found an outlier within 120 miles of James' Bay. On the Kenogami it extends to a point about half-way from Long Lake to the Albany. The northern limit intersects the east shore of Lake Winnipeg, and gains its highest latitude (about $54\frac{1}{2}°$) on the main Saskatchewan, where Mr. A. S. Cochrane last summer observed some good-sized trees not far from Cumberland House. Professor Macoun says he has "found it on Tail Creek, which discharges Buffalo Lake into Red Deer River, a branch of Bow River." In the plain country, near the United States boundary line, the writer met with fair-sized trees in valleys in the Wood Mountains, and in different valleys to the northward of them. The trees in such situations are not visible from the table-lands until the brink of the valley is reached, and are locally known as "sly-woods." It grows to a large size along the Red and Assiniboine Rivers.

Outlier.

Most northerly range.

Bow River.

In the plain country.

Ash-leaved maple.

11. ASH-LEAVED MAPLE, BOX ELDER, RED RIVER MAPLE (*Negundo aceroides*, Mœnch.)—Does not appear to have been found native in Quebec or Ontario, although occurring in the eastern states. Young trees raised at Montreal from seeds brought from Manitoba are growing very rapidly, and bearing seeds in the eighth year from sowing. In the North-West, Professor Winchell gives it as reaching the western extremity of Lake Superior. It is abundant in the Red River valley, and extends north to the Dog's Head on Lake Winnipeg, beyond which the writer has not found it in that direction. It occurs along the main

Montreal.

Lake Superior.

Saskatchewan and the south branch. The most westerly locality known is Tail Creek, which discharges Buffalo Lake, where it was found by Professor Macoun, along with the white elm. It is difficult to draw the geographical boundary of any tree in the prairie country, where timber of all kinds is so scarce, and therefore the lines on the map in this region are subject to correction. Buffalo Lake.

12. GREEN ASH, WESTERN ASH (*Fraxinus viridis*, Michx.)—Common along the Red River in Manitoba, and extends north-westward as far as the Saskatchewan, in the neighborhood of Cumberland House. Mr. A. S. Cochrane writes that he found it abundant, but of small size, at the Birch portage, in this vicinity. I have met with it at the elbow of the South Saskatchewan, and Professor Macoun says he has not seen it west of the Cypress Hills, but that it extends east as far as Owen Sound, on the Georgian Bay. It occurs on the Lake of the Woods and along the Rainy River. Green ash. Saskatchewan. Owen Sound.

13. BUR OAK (*Quercus macrocarpa*, Michx.)—The limit of this species in Canada extends from the international boundary on Lake Superior north-westward to the north end of Lake Winnipegosis, from which it drops south to the Dakota line, in the vicinity of the Souris River. Professor Winchell writes that it is scattered all over the state of Minnesota. It attains a good size on the Rainy River and in the district between Lake of the Woods and Winnipeg River and the Red River; also along the Red and Assiniboine Rivers. On the English River it was first observed about half-way from Lonely Lake to the Winnipeg River. It extends northward on Lake Winnipeg as a tree to the Loon Straits, and as a bush to Beren's River. Small trees occur along the Swan River and north branch of the Assiniboine. Professor Macoun has not noticed it west of Spy Hill, near the Qu'Appelle River. Bur oak. Dakota. Winnipeg River. N. and W. limits.

14. WHITE PINE—"Yellow Pine" of the British markets—(*Pinus strobus*, L.)—This and the next species have so nearly the same limit throughout the greater part of their northward range, that they are represented on the map both by one line. The red pine, however, does not extend so far east as the white, so that in this direction the line represents only the boundary of the latter. Contrary to popular belief, the white pine is confined to a comparatively small part of the Dominion, as will be observed by an inspection of the map. Its northern limit in Canada extends east as far as Mingan, while to the west it does not reach Lake Winnipeg, or Red River. It reaches its lowest latitude opposite to Ottawa City, about 48¾°, and its highest, about 52°, in the Lonely Lake region. It occurs in favorable situations throughout the greater part of Newfoundland, but it is of best quality and most abundant along the Gander and Exploit Rivers on the north, and the Humber on the west side of the island. On the last named stream, White pine. Area of pine. Lowest and highest latitudes. Newfoundland.

I have cut into the centres of several good-sized trees, and found the wood of excellent quality. In the country immediately north of Lake St. John, the Messrs. Price have cut large quantities of fine white pine timber for export. When coming from Lake Mistassini to Ottawa, by way of the Gatineau River, Mr. Richardson, of the Geological Survey, first met this species at 230 miles north of that city. It occurs of fair size on the head waters of all the principal branches of the Moose River, and in former times is said to have extended considerably further north along these streams; but having been entirely destroyed by extensive forest fires, it has been replaced by other trees. Owing to these fires it is now very scarce in most of the region north of Lake Superior, but small groves of it have been observed as far north as represented. It is scattered over the country between Lake Superior and the Winnipeg River and around Lonely Lake, but it is of rather small size. In approaching Lake Winnipeg the limiting line of this tree curves south-westward, and crosses the Winnipeg River about fifteen miles above Fort Alexander, and then runs south to the United States boundary at some distance east of Red River.

Lake St. John. Gatineau River. Moose River. Lake Superior. Winnipeg River.

Red pine.

15. RED PINE, NORWAY PINE (*Pinus resinosa*, Ait.)—As above stated, the northward range of this species and the white pine correspond so nearly, except towards the east, that for the present their limit is represented by a single line. It is not so common a tree in Canada as the white pine, and is usually found in rather small groves, although in the Ottawa valley they are sometimes pretty extensive. The white pine, on the other hand, may be found mixed with all other kinds of trees. It begins to disappear from the northern parts of the region of the white pine east of the longitude of Quebec, and is absent from Anticosti and Newfoundland. I have observed it in the Province of Quebec on the upper part of the Patapedia River, in the Gaspe peninsula, and Mr. Ells informs me that it is found on the Tobique River and on the New Brunswick and Canada railway fifty miles from St. Andrew's.

North-eastward range.

Yellow birch.

16. YELLOW BIRCH (*Betula excelsa*, Ait.)—The 49th parallel forms the average northern limit of this species from Newfoundland to the Red River valley, in which it curves round and runs southward. It grows to a good size in Newfoundland and the Maritime Provinces, where it is used in ship-building. Some of the trees whose northern boundaries are near that of the yellow birch in the east, gain much higher latitudes in the west. It ranges north of the height of land at Lake Abittibi, but is not found on the north shore of Lake Superior from Michipicoten to the United States boundary, and only small trees are found on the Canadian side of the line from this point to the Rainy River.

Newfoundland. Lake Superior.

17. Sugar Maple, Hard Maple, Rock Maple (*Acer saccharinum*, Wang.)—This tree, which was adopted as emblematic of Canada, is confined to the south-eastern borders of the Dominion. It is rather more southern in its tendency than the yellow birch. Some small trees have been noted at the head of Bay St. George, Newfoundland. It is found in sheltered places on the north side of the Gaspé peninsula, and is common in its southern parts, thrives well on the fertile limestone land of Lake St. John, and reaches Lake Temiscamang on the Ottawa; is abundant, but of a dwarfed description, on Michipicoten Island and the hills on the east side of Lake Superior. Going north in this region, the last trees were seen south of the Long portage, on the Michipicoten River. It is absent from the northern parts of the shores of Lake Superior and northward. On the west side of the lake it re-appears on the south side of the lower part of the valley of the Kaministiquia River, and thence the limit keeps westward, a little to the north of the boundary line, as far as Lake of the Woods, where it turns south. Sir John Richardson mentions this tree as occurring in the Saskatchewan region, but this is probably an error.

Sugar maple. Gaspé. Lake Superior. Lake of the Woods.

18. Red Oak (*Quercus rubra*, L.)—Nova Scotia, New Brunswick south of the Bay of Chaleur, Province of Quebec south of the city of the same name, and in Ontario to latitude 46°. On the north side of Lake Huron it is found for only a short distance inland. South shore of Lake Superior and at the eastern and western extremities. It has been said by one writer to occur on Michipicoten Island, but others familiar with the island have not observed it.

Red oak.

19. Hemlock, Hemlock-Spruce (*Abies Canadensis*, Michx.)—Eastward the northern limit of this species is at the Bay of Chaleur, but it is scarce near the eastern sea coast of New Brunswick. Very abundant in the northern part of Nova Scotia. It crosses the St. Lawrence a short distance below Quebec, extending further down on the north than on the south side. Thence it reaches the north end of Lake Temiscaming and the eastern extremity of Lake Superior at Agawa, south of the Michipicoten River. On the south shore of Lake Superior it does not reach the western extremity, turning southward in the neighborhood of Ashland. I am informed, however, that there is an outlying grove of hemlock at Thompson, about twenty-five miles west of Duluth. This tree maintains a good size to the verge of its range, and always appears to terminate abruptly. Sir John Richardson states that it grows on the Kaministiquia River. This, however, appears to be an error. I have never seen it or heard of its occurrence near this locality.

Hemlock. Maritime Provinces. Lake Superior.

20. Basswood, Linden, White Wood (*Tilia Americana*, L.)—Common in Nova Scotia and New Brunswick, except the northern part, not

Basswood.

Gulf of St. Lawrence. having been noticed beyond the southern branches of the Restigouche. The northern limit seems to reach the Gulf south of Miscou, from which it runs west to near Quebec, and thence in a pretty direct course to the eastern shore of Lake Superior. It is wanting around the northern parts of this lake, but re-appears just south of Thunder Bay, from which it nearly follows the international boundary to Lake of the Woods. Here it bends north-west, and almost gains the southern extremity of Lake Winnipeg, the last trees seen in that direction being at East Selkirk, on the Red River, where they are very small. Westward it is found along the Assiniboine to a short distance above Fort Ellice. Red River.

Beech. 21. BEECH (*Fagus ferruginea*, Ait.)—Throughout Nova Scotia and in New Brunswick to the Bay of Chaleur; except on the coast of the Bay of Fundy. The northern boundary crosses the St. Lawrence a short distance below Quebec, and thence runs west to Lake Nipissing and the outlet of Lake Superior. On the south shore of this lake it occurs as far west as Grand Island, but it seems to disappear from the immediate neighborhood of the lake before reaching L'Anse. Sir John Richardson says this tree occurs on Red River of Lake Winnipeg. If so, it must be south of the Canadian line. Bay of Fundy. Lake Superior.

White ash. 22. WHITE ASH (*Fraxinus Americana*, L.)—Found throughout Nova Scotia and in New Brunswick, except the northern part; also in the southern parts of Quebec and Ontario, its northward range corresponding nearly with that of the beech. It occurs along the southern, but not on the northern side of Lake Superior.

Ironwood. 23. IRON-WOOD, HOP HORNBEAM—Lever-wood of the Eastern Townships (*Ostrya Virginica*, Willd.)—Nova Scotia and the greater part of New Brunswick, the northern limit being on the Bay of Chaleur, from which it runs to near the city of Quebec, and reaches Lake Huron at the mouth of the French River. It has been seen on the Manitoulin Islands, but not to the north of Lake Huron. Sir John Richardson mentions it as occurring on the Winnipeg and Red Rivers, and I have noticed it on Lake of the Woods and the lower part of the Assiniboine River.

Blue beech. 24. BLUE BEECH, AMERICAN HORNBEAM (*Carpinus Americana*, Michx.)—This small tree does not range quite so far north as the last. It has not been noticed on the north side of Lake Huron, nor anywhere around Lake Superior.

White oak. 25. WHITE OAK (*Quercus alba*, L.)—In the southern parts of Nova Scotia and New Brunswick, in both of which it is rare. More common in the southern districts of Quebec and Ontario. A very valuable timber tree in the Ottawa valley, below the Mattawa, and throughout south-western Ontario, from both of which regions large quantities have hitherto been exported to foreign markets.

26. RED CEDAR (*Juniperus Virginiana*, L.)—The arborescent form of this species is found in none of the provinces except Ontario. Its northern limit begins on the Atlantic coast about the eastern part of the state of Maine, and runs west near the parallel of latitude 45°, crossing the St. Lawrence about mid-way between Montreal and Lake Ontario, and reaching Lake Huron at Parry Sound. In the early days of the settlement of Upper Canada large quantities of this wood were cut in the neighborhood of Kingston and the Bay of Quinté, and shipped out of the country. The prostrate variety (*J. humilis*, Hook.), is found in all the provinces, and is common in sandy and gravelly soil in the North-west prairie country. It also occurs in dry and rocky places along rivers and lakes in the wooded regions of the Hudson's Bay territories, as far north as the mouth of the Nelson River. Red cedar. Former abundance near Kingston. Prostrate variety.

27. BUTTERNUT (*Juglans cinerea*, L.)—Said to be found in Nova Scotia on the east side of the Bay of Fundy. Occurs in the southern counties of New Brunswick, especially King's, and along the St. John River above Woodstock; absent from the coast and northern part of this province; in the St. Lawrence valley, nearly as far down as the city of Quebec, and along the Ottawa up to the Madawaska, from which the northern boundary runs to the Georgian Bay. Large trees are found in a few places in the county of Grey, not far from this Bay. Butternut.

28. BITTER HICKORY (*Carya amara*, Nutt.)—Ranges over a much larger area in Canada than the shell-bark hickory, being found around Montreal, in the Eastern Townships and along the lower part of the Ottawa valley, and thence westward throughout the southern part of Ontario to Lake Huron. Bitter hickory.

29. BLACK WALNUT (*Juglans nigra*, L.)—This tree is confined to the tract lying south of a line drawn from the head of Lake Ontario to near the outlet of Lake Huron. Black walnut.

30. CHESTNUT (*Castanea vulgaris*, Lam., var. *Americana*, A. DC.)—In the district along the north side of Lake Erie, and north-eastward to the north shore of the head of Lake Ontario. Chestnut.

THE GEOGRAPHICAL DISTRIBUTION OF TREES OCCURRING IN CANADA BUT NOT REPRESENTED UPON THE ACCOMPANYING MAP.

1. TULIP TREE (*Liriodendron tulipifera*, L.—At Niagara Falls and in some localities westward near Lake Erie.

2. SILVER MAPLE, WHITE MAPLE (*Acer dasycarpum*, Ehrh.)—Eastern Townships and province of Ontario south of latitude 45°. Generally confounded with the red or soft maple.

3. STRIPED MAPLE (*Acer Pennsylvanicum*, L.)—This small tree, although everywhere scarce, has much the same range in Canada as the

sugar maple, being found from Gaspé to the outlet of Lake Superior; also with the sugar maple at Lake St. John.

4. MOUNTAIN MAPLE (*Acer spicatum*, Lam.)—The most northern species of maple. Ranges from Newfoundland to James' Bay, and north-westward to Island Lake on the waters which reach the sea at York Factory. The last locality at which it was seen in this direction is George's Island, in Lake Winnipeg.

5. BLACK MAPLE (var. *Acer nigrum*, Michx.)—Identified by the late Dr. John Bell as occurring at Grenville, on the Ottawa.

6. SOFT MAPLE, RED MAPLE (*Acer rubrum*, L.—A common tree throughout the Maritime Provinces, and in Quebec and Ontario south of latitude 49°; has a slightly more northern range than the sugar maple.

7. KENTUCKY COFFEE TREE (*Gymnocladus Canadensis*, Lam.)—Said to occur in southern Ontario. Professor Winchell informs me that it is found in the southern part of Minnesota.

8. WILD PLUM (*Prunus Americana*, Marshall.)—The northern limit runs from near the city of Quebec to the eastern extremity of Lake Superior. It occurs on the Rainy and the Red River and the lower part of the Assiniboine, and at the south end of Lake Manitoba.

9. PIGEON CHERRY, SMALL RED CHERRY (*Prunus Pennsylvanica*, L.) —Very widely diffused; has a high northern range, small examples extending in most regions nearly to the verge of the timber.

10. BLACK CHERRY (*Prunus serotina*, Ehrh.)—Formerly a valuable timber tree in the lower Ottawa region and south-western Ontario; very fine in the county of Bruce; now nearly exhausted.

11. MOUNTAIN ASH, ROWAN (*Pyrus Americana*, De C.)—Abundant and of good size in all the Maritime Provinces, Anticosti and Gaspé; thence it extends westward, the northern limit touching James' Bay. Further west it is found of small size as far west as Island Lake, on the Shamattawa, and to White Mud Falls, on the Nelson River, seventy or eighty miles below Lake Winnipeg. This tree, which is of a northern habit, probably attains its greatest perfection around the Gulf of St. Lawrence and Lakes Huron and Superior.

12. SCARLET-FRUITED THORN (*Cratægus coccinea*, L.)—Common in the southern and central latitudes of Quebec and Ontario, but its northern limits have not been accurately ascertained. Between Lake Superior and Manitoba thorn bushes grow as far north as the international boundary, but not much beyond it. Thorn bushes, apparently belonging to this species, were found by Mr. Cochrane on the Grassberry River, twenty or thirty miles north-west of Pine Island Lake.

13. COCKSPUR THORN (*Cratægus crus-galli*, L.)—Ontario, except the more northern parts. In Manitoba a thorn which appears to be identical with this species is abundant.

14. BLACK THORN (*Cratægus tomentosa*, L.)—In the southern parts of Quebec and Ontario.

15. FLOWERING DOG-WOOD (*Cornus florida*, L.)—In southern Ontario only. Most common apparently at Niagara Falls, and westward to the valley between Dundas and Ancaster, but rarer on the higher grounds.

16. SOUR-GUM (*Nyssa multiflora*, Wang.)—Dr. Hurlbert informs me that this tree grows in some parts of southern Ontario, but I have not observed it myself.

17. SASSAFRAS (*Sassafras officinale*, Nees.)—From the Niagara River to Ancaster, near the head of Lake Ontario, and probably other parts of southern Ontario.

18. SLIPPERY ELM (*Ulmus fulva*, Michx.)—Southern parts of Quebec. Along the Ottawa River for 200 miles, above Montreal; small and rather scarce. In Ontario as far north as Georgian Bay.

19. ROCK ELM (*Ulmus racemosa*, Thomas.)—Eastern Townships, Lower Ottawa valley and province of Ontario south of latitude 46°. Formerly common, but most of the finest trees in all these regions have been cut for export.

20. BUTTONWOOD, AMERICAN PLANE-TREE (*Platanus occidentalis*, L.)—Around the head of Lake Ontario and in the western peninsula, especially along rivers such as the Grand, Thames and Saugeen.

21. SHELL-BARK HICKORY (*Carya alba*, Nutt.)—In the southern part of Ontario; rather common in some localities. The brown hickory (*C. porcina*) and the white-heart hickory (*C. tomentosa*) are also believed to occur in the same region.

22. SWAMP-WHITE OAK (*Quercus bicolor*, Willd.)—The white oak of the low lands in the Ottawa valley and southern Ontario appears to belong to this species. Near Dundas I have also seen what I took to be the black oak (*Q. tinctoria*, Bartram.)

23. WHITE BIRCH (*Betula alba*, L.)—This species, which is often mistaken for the canoe birch, occurs in the Maritime Provinces, and in Quebec as far west as Montreal, and probably further.

24. BLACK BIRCH (*Betula lenta*, L.)—Often confounded with the yellow birch. Occurs in both Nova Scotia and New Brunswick. Identified in Gaspé and other places in the Province of Quebec, and in Ontario as far west as the Manitoulin Islands.

25. BLACK ALDER (*Alnus incana*, Willd.)—Abundant along streams everywhere from Newfoundland to the Saskatchewan, and as far north as the forests extend, but not in the southern parts of Ontario. In the Hudson's Bay territories it is often called "black willow." The green alder (*A. viridis*) has also been noticed, although not so common as the black, from Newfoundland to Lake Winnipeg, and northward to the verge of the forests around Hudson's Bay.

26. WILLOWS.—The willows have not been identified with sufficient specific accuracy in the various regions in which the aborescent forms occur to map the geographical range of the different species.

27. LARGE-TOOTHED POPLAR (*Populus grandidentata*, Michx.)—Of a southern habit compared with the aspen. Its northward range is somewhere between that of the sugar maple and the white pine. Abundant in New Brunswick, and Gaspé. It does not extend west as far as Manitoba.

28. COTTON-WOOD (*Populus monilifera*, Ait.)—Large trees occur along the Assiniboine River.

29. *Pinus contorta* (Dougl.)—Western part of the North-west Territories.

30. PITCH PINE (*P. rigida*, Mill.)—In some places in the Ottawa valley, and at the Thousand Islands on the St. Lawrence.

31. ENGELMANN'S SPRUCE (*Abies Engelmanni*, Parry.)—This tree, which is known to extend as far east as the Black Hills of Dakota, is said to occur also on the upper waters of the South Saskatchewan.

APPENDIX I.

LIST OF FOSSILS COLLECTED BY DR. R. BELL IN MANITOBA DURING THE SEASON OF 1880.

BY J. F. WHITEAVES.

1. FROM THE "GALENA LIMESTONE" (D. 2b. UTICA) OF EAST SELKIRK.

PROTOZOA.

Receptaculites Oweni, Hall.

CŒLENTERATA.

Columnopora cribriformis, Nicholson.
Columnaria alveolata, Goldfuss (=*Favistella stellata*, Hall).
Streptelasma corniculum? Hall.—Large and robust variety.

CEPHALOPODA.

Endoceras—like *proteiforme*, Hall, but with more closely arranged septa; also embryo tube of the same.
Orthoceras Simpsoni, Billings.
Orthoceras, Sp. Undt.

2. FROM THE "GALENA LIMESTONE" OF THE BANKS OF THE RED RIVER, IN THE PARISH OF ST. ANDREW'S.

PROTOZOA.

Receptaculites Oweni, Hall.

CŒLENTERATA.

Columnopora cribriformis, Nicholson.
Halysites catenularia, Linné.
Columnaria alveolata, Goldfuss, *non* Hall.
Monticulipora, N. Sp.—Fragments of a small branching form.
Monticulipora, N. Sp.—Portion of a massive hemispherical species.
Monticulipora, N. Sp.—Apparently allied to *M. undulata*, Nicholson.
Streptelasma corniculum? Hall, var.

POLYZOA.

Retepora Trentonensis, Nicholson.
Ptilodictya, Sp. Undt.—Fragments only.

BRACHIOPODA.

Rhynchonella capax, Conrad, var. *increbescens*, Hall.
Platystrophia biforata, Schlotheim, var. *lynx*.
Orthis testudinaria, Dalman.
Strophomena alternata, Conrad.
Strophomena camerata? Conrad.
Strophomena (?) Nov. Sp.
Streptorhynchus filitexta, Hall.
Leptæna sericea, Sowerby.

GASTEROPODA.

Murchisonia bellicincta, Hall.
Fusipira, Sp. Undt.—A frament of a cast.
Bucania, Sp. Undt., allied to *B. bidorsata*. Hall.
Bucania expansa? Hall. A badly preserved cast.
Cyrtolites ornatus? Conrad. A badly preserved cast.
Cyrtolites compressus, Conrad.

CEPHALOPODA.

Actinoceras Lyoni, Stokes.
Actinoceras Richardsoni, Stokes.

CRUSTACEA.

Leperditia, Sp. Undt.
Calymene senaria, Conrad.
Lichas Trentonensis, Conrad.
Illænus crassicauda, Hall, and D. D. Owen, as of Wahlenberg.
Cheirurus pleurexanthemus, Green.

3. FROM THE BANKS OF RED RIVER, PARISH OF ST. ANDREW'S, BUT APPARENTLY FROM A DIFFERENT AND HIGHER GEOLOGICAL HORIZON—PROBABLY THAT OF THE NIAGARA LIMESTONE.

CŒLENTERATA.

Thecia, Nov. Sp.
Eridophyllum, Sp. Undt.

BRACHIOPODA.

Stricklandinia, Nov. Sp.

CRUSTACEA.

Illænus (*Bumastes*) *Barriensis*, Murchison.

APPENDIX II.

List of Plants Collected in 1880.

The plants collected during the season are enumerated in the following list, which has been kindly prepared by Professor Macoun, F.L.S., of Albert University, Belleville, Ontario. The localities of the species are indicated by asterisks placed in the columns, which are designated as follows:—

I.—York Factory.
II.—Echimamish River to Oxford House.
III.—Oxford House to Knee Lake.
IV.—Around Cross Lake on Nelson River.
V.—Hayes' River.
VI.—Hill River.
A.C.—Plants Crossing the Arctic Circle.

Nos.		I.	II.	III.	IV.	V.	VI.	A.C.
	RANUNCULACEÆ.							
1	Anemone parviflora, Michx....						•	•
2	" multifida, D.C..................					•	•	•
3	" Pennsylvanica, L................	•	•					•
4	" Richardsoni, Hook..............	•						•
5	Thalictrum dioicum, L...................	•						•
6	" Cornuti, L..................	•						
7	Ranunculus aquatilis, L. var. trichophyllus, Gr.			•	•			•
8	" cymbalaria, Pursh..............	•						•
9	" sceleratus, L..................	•						•
10	" Flammula, L. var. reptans, Gr...		•					•
11	Caltha palustris, L..........................	•		•				•
12	Aquilegia Canadensis, L..................			•				•
13	Actæa spicata, L. var. rubra, Gr.............			•	•			
	SARRACENIACEÆ.							
14	Sarracenia purpurea, L.....................				•			•

Nos		I.	II.	III.	IV.	V.	VI	A.C.
	FUMARIACEÆ.							
15	Corydalis glauca, Pursh....................							•
16	" aurea, Willd....................	•			•	•		
	CRUCIFERÆ.							
17	Nasturtium palustre, D.C..................	•	•					•
18	Cardamine hirsuta, L......................	•						•
19	Arabis petræa, Lam........................	•						•
20	Erysimum cheiranthoides, L................	•						•
21	Sisymbrium sophioides, Fischer............	•						•
22	Draba incana, L...........................	•						
23	Lepidium intermedium, Gray...............			•				
	VIOLACEÆ.							
24	Viola palustris, L........................			•				•
	CARYOPHYLLACEÆ.							
25	Lychnis apetala, L........................	•						•
26	Arenaria lateriflora, L....................	•						•
27	" verna, L........................	•						•
28	" formosa, Fischer................	•						•
29	" nardifolia, Ledib ?.............					•		
30	" peploides, L....................	•						•
31	Stellaria media, L........................	•						
32	" longifolia, Muhl...............	•						•
33	" borealis, Bigel.................	•		•				•
34	" uliginosa, Murr................	•						•
35	" longipes, Goldie...............		•					•
36	Sagina nodosa, Fenzl.....................	•						•
	GERANIACEÆ.							
37	Geranium Carolinianum, Linn.............			•				
	RHAMNACEÆ.							
38	Rhamnus alnifolius, L'Her................			•			•	
	LEGUMINOSÆ.							
39	Astragalus hypoglottis, Ker...............					•		•
40	Hedysarum Mackenzii, Rich...............					•		•
41	Vicia Americana, Muhl....................	•	•					•
42	Lathyrus ochroleucus, Hook...............			•				•
43	" palustris, L....................				•			
	ROSACEÆ.							
44	Prunus Pennsylvanica, L..................							
45	Geum strictum, Ait.......................	•	•					
46	Fragaria Virginiana, Ehrh................		•					
47	Potentilla Norvegica, L...................		•					•
48	" Anserina, L....................	•	•					

Nos.		I.	II.	III.	IV.	V.	VI.	A.C.
	Rosaceæ.—(*Continued.*)							
49	Potentilla fruticosa, L.							•
50	" tridentata, Ait.		•		•			•
51	palustris, Scop.	•	•		•			•
52	diversifolia, Lehm.	•	•					
53	Rubus Chamæmorus, L.			•				•
54	arcticus, L.			•				•
55	strigosus, Mich.		•					
56	Rosa blanda, Ait.	•	•					•
57	Amelanchier Canadensis, var. oblongifolia.				•			•
	" " var. Botryapium.		•					
	Saxifragaceæ.							
58	Ribes lacustre, Poir.			•				•
59	" prostratum, L'Her.		•					
60	" Hudsonianum, Rich.			•	•			•
61	" rubrum, L.	•		•				•
62	" oxycanthoides, L.			•				
63	Parnassia palustris, L.	•		•	•			•
64	Saxifraga Hirculus, L.	•						•
65	" tricuspidata, Retz.	•						•
66	Heuchera hispida, Pursh.		•					•
67	Mitella nuda, L.	•		•				•
	Halorageæ.							
68	Hippuris vulgaris, L.	•						•
	Onagraceæ.							
69	Epilobium augustifolium, L.	•	•					•
70	" palustre, var. lineare, Gr.			•				•
71	" tetragonum, L.	•	•					
	Umbelliferæ.							
72	Cicuta virosa, L.	•						
73	Sium lineare, Michx.		•		•			•
74	Carum Carui, L.			•				
	Araliaceæ.							
75	Aralia hispida, Michx.				•			
	Cornaceæ.							
76	Cornus Canadensis, L.			•				•
77	" stolonifera, Michx.	•	•					•
	Caprifoliaceæ.							
78	Linnæa borealis, Gronov.	•		•				
79	Symphoricarpus racemosus, Michx.	•		•				
80	Lonicera involucrata, Banks.			•				
81	" parviflora, Lam.		•					
82	" cærulea, L.			•			•	
83	Viburnum pauciflorum, Pylaie.	•	•		•			
	Rubiaceæ.							
84	Galium trifidum, L.	•						•
85	" boreale, L.	•				•		•

Nos.		I.	II.	III.	IV.	V.	VI.	A.C.
	COMPOSITÆ.							
86	Nardosmia palmata, Hook			•				•
87	" sagittata, Benth	•						
88	Aster graminifolius, T. & G		•				•	
89	" puniceus, L	•						
90	Erigeron acre, L	•				•		
91	Solidago lanceolata, Ait				•			
92	" Canadensis, L	•						
93	Achillæa millefolium, L		•					•
94	Leucanthemum arcticum, D.C	•						•
95	Matricaria inodora, L	•						•
96	Tanacetum Huronense, Nutt					•		
97	Artemisia Canadensis, Michx					•		
98	Antennaria dioica, Gærtn, var. rosea, Wat	•						•
99	" plantaginifolia, Hook		•					
100	" Carpathica, R. Br	•						
101	Senecio palustris, Hook	•						•
102	" aureus, L	•	•			•		•
103	" ———?	•						
104	Arnica augustifolia, Vahl		•					
105	" foliosa	•						
106	Hieracium Canadense, Mich., var. umbellatum, Rich					•		
107	Nabalus racemosus, Hook					•		
108	Taraxacum palustre, D.C			•				•
109	Mulgedium pulchellum, Nutt						•	•
	CAMPANULACEÆ.							
110	Campanula rotundifolia, L		•		•			•
	ERICACEÆ.							
111	Vaccinium oxycoccus, L	•						•
112	" Canadense, Kalm		•					•
113	" Vitis-Idæa, L			•				•
114	" uliginosum, L		•					•
115	" macrocarpon, Ait	•						
116	Arctostaphylos uva-ursi, Spreng		•					
117	" alpina, Spreng	•						
118	Cassandra calyculata, Don						•	
119	Ledum palustre, L					•		•
120	" latifolium, Ait	•		•		•		
121	Pyrola minor, L			•				•
122	" secunda, L			•				•
123	" rotundifolia, L		•		•			•
124	" elliptica, Nutt				•			
125	Moneses uniflora, Gray	•		•				
	PLANTAGINACEÆ.							
126	Plantago major, L					•		•

Nos.		I.	II.	III.	IV.	V.	VI.	A.C.
	Primulaceæ.							
127	Primula farinosa, L.	•						
128	" Mistassinica, Michx					•		
129	Lysimachia thyrsiflora, L.			•				
	Lentibulaceæ.							
130	Utricularia vulgaris, L.	•	•		•			•
131	Pinguicula vulgaris, L.	•						•
	Scrophulariaceæ.							
132	Castilleia pallida, var. septentrionalis	•		•		•		•
133	Euphrasia officinalis, L.	•	•					•
134	Rhinanthus crista-galli, L.	•				•		•
135	Pedicularis Grœnlandica, Retz	•						
136	" palustris, var. Wlassoviana, Bunge	•						
	Labiatæ.							
137	Mentha Canadensis, L.				•			
138	" " var. glabrata		•					
139	Lycopus Virginicus, L.			•				
140	Scutellaria lateriflora, L.		•	•	•		•	
141	Stachys palustris, L.		•	•				•
	Boraginaceæ.							
142	Mertensia paniculata, Don.	•	•					
	Polemoniaceæ.							
143	Collomia linearis, Nutt.	•						
	Gentianaceæ.							
144	Gentiana amarella, L., var. acuta, Gr.	•		•				•
145	" detonsa, Fries.	•						•
146	" propinqua, Rich	•						•
147	Halenia deflexa, Griesb.					•		
148	Pleurogyne rotata, L.	•						•
149	Menyanthes trifoliata, L.	•			•			•
	Apocynaceæ.							
150	Apocynum androsæmifolium, L.	•						
	Chenopodiaceæ.							
151	Chenopodium album, L.	•						•
152	Blitum capitatum, L.					•		
	Polygonaceæ.							
153	Polygonum amphibium, var. aquaticum				•			
154	" viviparum, L.	•		•				•
155	" maritimum, L.	•						
156	Rumex salicifolius, Wein	•						•
157	" orbiculatus, Gray	•						

Nos.		I.	II.	III.	IV.	V.	VI.	A.C
	ELÆAGNACEÆ.							
158	Elæagnus argentea, Pursh................						•	•
159	Shepherdia Canadensis, Nutt.............	•					•	•
	SANTALACEÆ.							
160	Comandra umbellata, Nutt................	•			•			
161	" livida, Rich....................		•					•
	EMPETRACEÆ.							
162	Empetrum nigrum, L.....................	•						•
	URTICACEÆ.							
163	Urtica gracilis, Ait.......................	•						
	MYRICACEÆ.							
164	Myrica Gale, L..........................						•	
	BETULACEÆ.							
165	Betula glandulosa, Michx..................		•		•			
166	Alnus incana, Willd......................		•		•			•
	SALICACEÆ.							
167	Salix candida, Willd......................	•						
168	" cordata, Muhl......................			•				
169	" discolor, Muhl......................							
170	" myrtilloides, L....................	•						•
171	" Novæ-Anglicæ, And	•						
172	" reticulata, L......................	•						•
173	" vestita, Pursh.....................						•	
174	" ——— ?..........................	•						
175	" ——— ?..........................	•						
176	" ——— ?..........................	•						
177	" ——— ?..........................						•	
178	" ——— ?..........................			•			•	
	CONIFERÆ.							
179	Juniperus communis, L..................						•	•
180	" Sabina, var. procumbeus, P......	•			•			
	ALISMACEÆ.							
181	Triglochin palustre, L....................					•		•
182	" maritimum, L................	•						•
183	Sagittaria variabilis, Engelm..............		•	•	•			

Nos.		I.	II.	III.	IV.	V.	VI.	A.C.
	ORCHIDACEÆ.							
184	Habenaria hyperborea, Lindl	•	•	•		•		•
185	" obtusata, Rich	•	•					•
186	Spiranthes Romanzoviana, Cham			•				
187	Listera convallarioides, Rich					•		
188	Corallorhiza innata, R. Br		•					
189	Cypripedium pubescens, Willd		•					•
	IRIDACEÆ.							
190	Sisyrinchium Bermudianum, L					•		•
	LILIACEÆ.							
191	Tofieldia palustris, Huds						•	•
192	Smilacina stellata, Desf		•					
193	" trifolia, Desf	•						
194	" bifolia, Ker		•					•
195	Lilium Philadelphicum, L		•					
	JUNCACEÆ.							
196	Luzula parviflora, Desv., var. melanocarpa					•		•
197	Juncus Balticus, Deth			•				
198	" castaneus, Smith	•						•
199	" tenuis, Willd		•					
200	" ——?					•		
	CYPERACEÆ.							
201	Eleocharis palustris, R. Br	•						•
202	Scirpus cœspitosus, L	•						•
203	" Eriophorum, Michx		•					
204	" atrovirens, Muhl			•	•			
205	Eriophorum gracile, Koch	•						
206	Carex atrata, L					•		•
207	" aurea, Nutt			•				
208	" gynocrates, Wormsk	•						•
209	" scoparia, Schk		•					
210	" stricta, Lam	•						
211	teretiuscula, Good	•						
212	utriculata, Schk	•						
	GRAMINEÆ.							
213	Agrostis scabra, Willd					•		
214	Calamagrostis stricta, Trin	•				•		
215	Glyceria nervata, Trin			•				
216	" aquatica, Smith	•						
217	" ——?	•						
218	Poa alpina, L	•						•
219	" ——?	•						
220	Bromus ciliatus, L			•				•
221	Triticum repens, L			•				•
222	" dasystachyum, Gray	•	•					
223	Aira cœspitosa, L			•				
224	Hierochloa borealis, Roem. & Schultes			•				
225	Beckmannia erucæformis, Hook					•		

Nos.		I.	II.	III.	IV.	V.	VI.	A.C.
	EQUISETACEÆ.							
226	Equisetum sylvaticum, L.			•	•			•
227	" pratense, Ehrh.	•		•				
228	" arvense, L.	•						•
229	" palustre, L.	•						•
230	" limosum, L.							
231	" scirpoides, Michx			•				•
	FILICES.							
232	Polypodium vulgare, L.				•		•	•
233	Allosorus acrostichoides, Spreng		•		•			•
234	Phegopteris Dryopteris, Fee		•					•
235	Cystopteris fragilis, Benth		•					•
236	Woodsia Ilvensis, R. Br.		•		•			•
237	Botrychium lunaria, Swartz		•	•				•
238	" Virginicum, Swartz			•				
	LYCOPODIACEÆ.							
239	Lycopodium clavatum, L.		•					•
240	" complanatum, L.			•				
	MUSCI.							
241	Sphagnum acutifolium, Ehrh.	•						
242	Polytrichum juniperinum, Hedw.	•						
243	" commune, L.							
244	Bryum nutans, Schreb.	•						
245	" bimum, Schreb.	•						
246	Aulacomnium palustre, L.	•						
247	Mnium affine, Bland			•				
248	" cuspidatum, Hedw.	•						
249	Hypnum cordifolium, L.	•		•				
250	" nitens, Schreb.	•						
251	" Schreberi, Willd		•					
	HEPATICÆ.							
252	Marchantia polymorpha, L.	•		•				
253	Jungermannia exsecta, Schmid.	•						
	LICHENES.							
254	Usnea barbata, Fries	•						
255	Alectoria jubata, Ach.	•						
256	Peltigera aphthosa, Hoffm.	•						
257	Cladonia cornuta, Fr.	•						
258	" cornucopioides, Fr.	•						
259	" rangiferina, Hoffm.	•						
260	" " var. alpestris, Trit.	•						
261	" gracilis, var. hybrida, Ach.	•						

Professor Macoun also gives the following interesting notes and grouping of the species:—"The greater number of the species belong to the Ontario flora, but there are a large number of these which are only found in the cold woods bordering the shores of Lake Superior. These are boreal or Alpine in their habit, and are given in the accompanying list. Those which have been detected also in the Rocky Mountains are followed by the letter R., while the species which cross these mountains are followed by the letter W.

Lake Superior Species.

Anemone parviflora. R.
" multifida. W.
Ranunculus Cymbalaria. W.
Arabis petræa. W.
Draba incana. W.
Viola palustris. W.
Sagina nodosa. W.
Vicia Americana. W.
Potentilla tridentata. R.
Parnassia palustris. W.
Lonicera involucrata. W.
" cœrulea. R.
Viburnum pauciflorum. W.
Aster graminifolius. Slave Lake.
Erigeron acre. California.
Tanacetum Huronense. W.
Nabalus racemosus. Prairies.
Vaccinium Vitis-Idæa. W.
" uliginosum. W.
Pyrola minor. R.
Pinguicula vulgaris.
Castilleia pallida. Var.
Mertensia paniculata. R.
Halenia deflexa. R.
Polygonum viviparum. W.
Comandra livida. W.
Empetrum nigrum. W.
Luzula parviflora. Var. W.
Carex atrata. R.
Poa alpina. W.
Allosorus acrostichoides. W.
Botrychium lunaria.

All the above species grow either on islands in Lake Superior or close to its shores, and indicate a low summer temperature, which doubtless exists where they were obtained.

The following have been detected either on the Gulf of St. Lawrence or close to its shores.

Arenaria peploides. W.
Stellaria uliginosa. R.
Astragalus hypoglottis. W.
Rubus Chamæmorus. W.
" articus. W.
Antennaria Carpathica. W.
Arctostaphylos alpina. R.
Ledum palustre. Alaska.
Euphrasia officinalis. R.
Rhinanthus Crista-galli. W.
Pedicularis Grœnlandica. W.
Collomia linearis. W.
Gentiana acuta. W.
Pleurogyne rotata. R.
Polygonum maritimum.
Salix vestita. R.
Juncus castaneus.

There are likewise a few which extend southward and become mixed with the prairie flora (P.), but have not been detected in the Maritime Provinces. Others, again, are found in the Rocky Mountains, and often pass southwards into the United States. These are indicated by the letter R.

Anemone Richardsoni. R.
Arenaria verna. R.
" formosa. R.
" nardifolia. R.
Potentilla diversifolia. R.
Ribes Hudsonianum. R.
Saxifraga Hirculus. Saskatchewan.
" tricuspidata. Lake Winnipeg.
Heuchera hispida. P.
Epilobium tetragonum. P.
Cicuta virosa. P.
Nardosmia sagittata. P.
Leucanthemum articum. W.
Senecio palustris. P.

Arnica foliosa. P.
Mulgedium pulchellum. P.
Hedysarum Mackenzii. P.
Pedicularis palustris. Var. W.
Gentiana propinqua. R.
Elæagnus argentea. P.
Salix reticulata. R.
Tofieldia palustris. R.
Triticum dasystachyum. P.
Beckmannia erucæformis. P.

Only two species remain to be accounted for: one, Sisymbrium sophioides, seems to be very local, unless it be united to S. Sophia, which is reported from Quebec. Matricaria inodora is more northern than any of the others, and is reported from far north of Hudson's Bay.

On the whole, the collection indicates a much better climate than is generally supposed to be found near Hudson's Bay, and no plants that seem to have been collected a few miles from it show a more boreal climate than is to be found in Quebec, where wheat and other cereals have been cultivated for many years. I consider the collection a representative one, as it evidently contains all the more prominent species. It is true, many of them are shore plants, or those found along river margins, but this fact does not make any material difference as regards the climate, since the river banks seem to indicate the extremes of temperature in any given locality.

There are a few species not enumerated, of which I am in doubt. These I shall send away and get named very shortly."

APPENDIX III.

LIST OF COLEOPTERA COLLECTED IN 1880 IN MANITOBA AND BETWEEN LAKE WINNIPEG AND HUDSON'S BAY.

I am again indebted to Dr. J. L. LeConte, of Philadelphia, the well-known entomologist, for kindly determining the Coleoptera which we collected last season. The specimens were obtained in four different localities, and the names of the species from each of them are given separately. In regard to this collection, Dr. LeConte remarks:—"There are, as you will observe, no undescribed species except one *Graphoderes*, which we had from other localities, and which will appear in a monograph of Dytiscidæ, soon to be published by the Royal Society of Dublin. There are some few species, notably in the *Lirus* (or *Curtonotus*) group of Amara, which, on account of the number of indefinite forms in the books, cannot be named with precision. I have kept all the specimens of that group, so that at a future time Dr. Horn or myself may endeavor to establish the species in more limited number, but with more distinct characters."

York Factory, Hudson's Bay. August and September.

1. Carabus tædatus.
2. " Chamissonis.
3. Platynus stygicus. Newfoundland to Alaska.
4. Pterostichus punctatissimus.
5. " oriponum.

6, 7. Cernara (Lirus.) Two species; one undetermined, the other seems to be C. reflexa, Putz. The species of this set are indefinite and opinionative, and require re-arrangement.

8. Bembidium lucidum.
9. Hydroporus impressopunctatus.
10. " ovoideus.
11. " Undetermined; near Schönherri of Europe.
12. " modestus.
13. " tartaricus.
14. " subtonsus.

15. Gaurodytes longulus. Lec.
16. Graphoderes. To be described by Dr. Sharp. Mass. to H. B. T.
17. Helophorus lineatus.
18. Philhydrus perplexus.
19. Hydrobius fuscipes.
20. Aphodius leopardus.
21. Ellychnia corrusca, race lacustris.
22. Clerus undatulus.
23. Criocephalus agrestis.
24. Merium Proteus.
25. Monohammus scutellatus.
26. Gonioctena pallida.
27. Acalyptus carpini.

Norway House to Oxford House. July.

1. Notiophilus Hardyi.
2. Carabus palustris.
3. Metabletus borealis.
4. Cymindis cribricollis. Dej.
5. Pterostichus punctatissimus.
6. " orinonum.
7. Amara (Lirus) reflexa. Putz.
8. " " cylindrica. Lec.
9. " protensa. Putz.
10. Harpalus herbivagus.
11. Bembidium bimaculatum.
12. Creophilus villosus.
13. Silpha lapponica.
14. Anisotoma (undetermined fragments.)
15. Pediacus fuscus.
16. Anatis 15-punctata.
17. Dermestes talpinus.
18. Saprinus oregonensis.
19. Aphodius leopardus.
20. Trichius affinis.
21. Buprestis Nuttalli.
22. Chrysobothris trinervia.
23. Corymbites triundulatus.
24. Scirtes tibialis.
25. Podabrus puberulus.
26. Telephorus fraxini.
27. " nigritulus. Lec; n. sp.

28. Clerus undatulus.
29. Merium Proteus.
30. Xylotrechus undulatus.
31. Neoclytus leucogonus.
32. Acmæops Proteus.
33. " pratensis.
34. Leptura subargentata. Var. similis.
35. Monohammus scutellatus.
36. Donacia proxima.
37. Gonioctena pallida.
38. Galeruca sagittariæ.
39. Graptodera bimarginata.
40. " Not determined.
41. Tenebrio molitor.

Lower Fort Garry, Manitoba. June and July.

1. Carabus tædatus, race Agassii.
2. Platynus cupripennis.
3. " cupreus.
4. " placidus.
5. " retractus.
6. " obsoletus.
7. " quadripunctatus.
8. Pterostichus orinonum.
9. " caudicalis.
10. " (Poecilus) lucublandus.
11. Amara (Lirus) cylindrica. Lec.
12. " (Bradytus) avida.
13. " fallax.
14. " obesa.
15. " musculus.
16. Agonoderus pallipes.
17. Harpalus amputatus.
18. " pennsylvanicus.
19. " pleuriticus.
20. " herbivagus.
21. Bradycellus rupestris.
22. Bembidium salebratum.
23. Berosus striatus.
24. Listrotrophus cingulatus.
25. Onthophagus Hecate.
26. Aphodius validus.

27. Aphodius ruricola.
28. Trichius affinis.
29. Dicerca prolongata.
30. Buprestis fasciata, race Langi.
31. Melanophila appendiculata.
32. Elater apicatus.
33. Agriotes fucosus.
34. Podabrus modestus.
35. Gastrophysa polygoni.
36. " cyanea.
37. Chelymorpha argus.
38. Tenebrio molitor.

Cross Lake, Nelson River. July.

1. Notiophilus Hardyi.
2. Carabus palustris.
3. " serratus.
4. Calathus ingratus.
5. Platynus sinuatus.
6. " melanarius.
7. Pterostichus orinonum.
8. " mandibularis.
9. Amara (Lirus) cylindrica.
10. " fallax.
11. " Sp. Indt.
12. " interstitialis.
13. Harpalus pleuriticus.
14. Bembidium bimaculatum.
15. " nitens.
16. Laccophilus proximus.
17. Silpha lapponica.
18. " trituberculata.
19. Creophilus villosus.
20. Dicerca prolongata.
21. Buprestis maculiventris, race rusticorum.
22. Corymbites æripennis.
23. Clerus undatulus.
24. Criocephalus agrestis.
25. Merium Proteus.
26. Xylotrechus undulatus.
27. Pachyta liturata.

28. Donacia proxima.
29. " magnifica.
30. " hirticollis.
31. " subtilis.
32. Plagiodera interrupta.
33. Galeruca sagittariæ.
34. Hypolampsis pilosa.
35. Œdisnychis scripta.
36. Upis ceramboides.

APPENDIX IV.

MOLLUSCA.

The following list contains the names of some species not enumerated in my report for 1879, and additional localities for others which were there mentioned. With two or three exceptions, the species were determined by Mr. J. F. Whiteaves.

A.—Land and Fresh Water.

1. *Vitrina limpida*, Gould. In damp woods at Norway House.
2. *Patula striatella*, Anthony. In the woods around the lakes of the Winnepeg basin.
3. *Succinea ovalis*, Gould, non Say. From Norway House to York Factory. Very numerous at the latter place among grass on damp ground which is occasionally covered with fresh water at high tide.
4. *Limnæa stagnalis*, Linn. In nearly all the lakes, streams, and marshes from Manitoba to York Factory.
5. *Limnæa (Bulimnea) megasoma*, Say. This fine species was found living in considerable numbers in the Echimamish River, between the Nelson and the height of land. Its discovery at this place is interesting on account of its great distance to the northward of previously known localities for the species.
6. *Limnæa (Limnophysa) palustris*, Mull. (=*L. elodes*, Say.) Numerous and fine in ponds at York Factory; also abundant in ponds along the Red River in Manitoba.
7. *Limnæa (Limnophysa) catascopium*, Say. Common in different parts of Oxford Lake.
8. *Physa* —— ? Small specimens of a *Physa* resembling the *P. elliptica* of Lea, but possibly distinct therefrom, were found in ponds at York Factory.
9. *Bulinus hypnorum*, Linn. (=*Physa elongata*, Say.) This species occurs in ponds all the way from Manitoba to York Factory.
10. *Planorbis (Planorbella) campanulatus*, Say. Abundant in Lake Winnipeg and in the Red and Nelson Rivers.

11. *Planorbis* (*Helisoma*) *trivolvis*, Say. Some very large specimens of this species were collected in the Echimamish River, on the west side of the height of land. Although common in ponds, marshes and rivers to the south and west, it was not observed to the northward of this locality.

12. *Planorbis* (*Helisoma*) *bicarinatus*, Say. A peculiar variety of this species occurs in Lake Manitoba.

13. *Segmentina armigera*, Say. In ponds between Forts Ellice and Pelly. Collected there in 1874.

14. *Sphærium striatinum*, Lam. (=*Cyclas edentula*, Say.) Ponds at York Factory.

B.—Marine.

15. *Buccinum tenue ?* Gray. Shores of Hudson's Bay near York Factory.

16. *Natica* (*Acrybia*) *flava ?* Gould. On the east coast of Hudson's Bay.

17. *Littorina palliata*, Say. On rocky parts of both shores.

18. *Mya arenaria*, Linn.	Richmond Gulf.		
19. *Mya truncata*, Linn.	"		
20. *Macoma calcarea*, Chemn.	East coast of Hudson's Bay.		
21. *Macoma fragilis*, O. Fabr.	"	"	"
22. *Cardium Islandicum*, Chemn.	"	"	"
23. *Astarte lactea*, Brod. & Sby.	"	"	"
24. *Mytilus edulis*, Linn.	"	"	"
25. *Pecten Islandicus*, Chemn.	"	"	"

APPENDIX V.

ANALYSIS OF THE WATERS OF HAYES' AND NELSON RIVERS.

The three samples analysed were collected:—

No. 1.—On the 15th August, 1880, five wine bottles from Hayes' River, opposite York Factory.

No. 2.—On the 11th August, 1880, five wine bottles from the mouth of Nelson River.

No. 3.—One wine bottle from Nelson River, below Sea River Falls, or forty miles in a straight line below the outlet of Lake Winnipeg.

They were put directly into clean glass bottles, and immediately sealed. After arrival in England the weather became so cold that had the samples been sent to Montreal for analysis, the frost would probably have burst the bottles. It was, therefore, deemed advisable to have them examined in Britain, and for this purpose they were handed to Professor William Dittmar, of Anderson's College, Glasgow, one of the best known water-analysts in the Kingdom. The following is his report:—

These three waters contained deposits which, in each case, were removed by filtration of the whole sample through asbestos. Hence the analyses of the saline components to be given refer to the clarified waters. All the waters contained traces of *organic* matter, which, however, was left undetermined, because after the execution of duplicate analyses of Nos. I. and II., and an analysis of No. III., there was not enough of water left for the execution of any of the modern methods (*e.g.*, determination of organic carbon and nitrogen). The mere determination of the loss of the total solids on ignition is of no value whatever.

No. I.—(Hayes' River.)

One Imperial gallon contains in grains:—

Suspended matter, dried at 105° C.	·875
Leaving on ignition	·567

Salts in Filtrate.

Silica	0·920
Sesquioxides (Al_2O_3 and Fe_2O_3)	0·190
Lime	2·480
Magnesia	0·700
Potash	0.133
Soda	0·456
Sulphuric acid	*nil.*
Chlorine*	0·247
Carbonic acid of the carbonates, reckoned as $R'' Co_3$	2·960
Total	8·086
* Oxygen, equivalent of Cl	·056
Total salts	8·030

Hardness Determined directly by Clark's Process.

NOTE.—1° of hardness means soap-destroying power equal to one grain of carbonate of lime per gallon.

Total	5° 9
Permanent	2° 4

No. II.—(Nelson River.)

One Imperial gallon contains in grains:—

Suspended matter, dried at 150° C	0·552
Leaving on ignition	0·198

Salts in Filtrate.

Silica	0·915
Sesquioxides	0·080
Lime	2·790
Magnesia	1·180
Potash	0.147
Soda	1·050
Sulphuric acid (So_3)	4·370
Chlorine*	0·586
Carbonic acid of the carbonates, taken as $R'' Co_3$.	1·542
Total	12·660
* Ox., equivalent of Cl., = ·132 ; ∴ Total salts	12·528

Hardness by Clark's Method.

Total	8° 55
Permanent	1° 78

No. III.—(Nelson River, Below Sea River Falls.)

A complete analysis of this water was started, but, unfortunately, lost when half completed, and owing to the smallness of the sample it could not be repeated.

Found—Grains, per Imperial gallon:—

Suspended matter, dried at 105° C.	2·565
Leaving on ignition	·734

In Filtrate.

Silica	0·576
Lime	2·576
Magnesia and alkalies	Lost.
Sulphuric acid proved absent.	
Chlorine	0.1421
Carbonic acid in the carbonates, considered as R″ Co_2 (in this case determined acidimetrically by titration, with aurine as indicator)	2·64

Total solids (dried at 105° C.,) determined directly (in only 70 grains	17·1 (Gr. per gal.)
Leaving on ignition	7·5

Sesquioxides absent.
Hardness not determined.

(Signed), W. DITTMAR

Anderson's College, Glasgow,
4th June, 1881.

APPENDIX VI.

YORK FACTORY.

Seasonal or Periodic Events.

1875—April 25.....	First rain of year.
May 3.......	Geese first seen.
May 6.......	Plover first seen.
May 14-15....	Game birds passing north in great numbers.
May 19......	River broke up with great violence; water 29 feet above low water mark.
June 13......	Swallows first seen.
June 18......	First thunderstorm, and first mosquitoes.
August 1.....	Fireflies seen.
September 8..	First snow.
September 9..	First frost.
1876—January 31...	Thickness of ice in current, 3′ 8″.
February 29..	Do. do. do. 4′ 7″.
April 30.....	Do. do. do. 5′ 1″.
April 27.....	First rain of year.
May 10......	River broke up; cleared out on 15th.
May 14......	Frogs first heard.
May 24......	First thunder.
June 5.......	Last snow of season.
June 26-27...	From 4 p.m to 9 a.m. 3 in. of rain fell.
July 26......	In forty minutes 2.7 in. of rain fell.
August......	From 3 p.m. of 23rd to noon of 25th 8.3 in. of rain fell.
September 28.	First snow of season.

YORK FACTORY.

SEASONAL OR PERIODIC EVENTS—Continued.

November 30.	Thickness of ice in current, 1′ 5″.
December 31.	Do. do. do. 3′ 8″.
1877—January 31...	Thickness of ice in current, 4′ 8″.
February 28..	Do. do. do. 5′ 2″.
April 28.....	First goose seen.
May 13......	First rain of season.
May 21......	River clear of ice.
May 27......	First thunder.
June 24......	Hoar frost.
July 28......	From 0 a.m. to 3 p.m. 7.6 in. of rain fell.
1878—March 17....	Snow-birds seen; first of season. Thickness of ice on river, 5′ 8″.
April 4......	First rain of year.
April 22.....	Goose seen.
April 23.....	Ducks seen.
April 25.....	Snipe seen.
April 26.....	Frogs heard.
April 27.....	Robins seen.
May 15-16...	Ice on river breaking up.
May 29......	Last snow.
June 1.......	Mosquitoes seen.
June 9.......	First thunderstorm.
June 20......	Fireflies seen.
June 27......	4.3 in. of rain fell during thunderstorm.
September 9..	6.5 in. of rain fell during day.
September 10.	First snow of season.
September 20.	4.1 in. of rain fell during day.
November 1..	River frozen over at Fort.
December 31.	Thickness of ice on river, 2′ 8″.

APPENDIX VII.

YORK FACTORY.

TABLE SHOWING DATES OF THE OPENING AND CLOSING OF HAYES' RIVER, AT YORK FACTORY, COMPILED FROM AUTHENTIC RECORDS BY MR. WILLIAM WOOD, METEOROLOGIST, YORK FACTORY.

YEAR.	RIVER OPENED.	RIVER CLOSED.	REMARKS.
1828....	June 1	November 15	Opposite Fort.
1829....	May 10	" 11	Ditto.
1830....	" 17	December 2	Ditto. A remarkably fine season.
1831....	" 22	November 28	Ditto. " "
1832....	" 25	" 26	Ditto.
1833....	" 13	" 22	Ditto.
1834....	" 27	" 20	Ditto.
1835....	" 24	" 18	At Mile Sand.
1836....	" 16	" 29	Opposite Fort.
1837....	" 11	" 25	Ditto.
1838....	" 23	" 22	Ditto.
1839....	" 22	" 19	Fast on the 19th, and opened again till 27th.
1840....	" 12	" 16	At Mile Sand.
1841....	" 10	" 13	Ditto.
1842....	" 17	" 11	Ditto.
1843....	" 29	" 11	Ditto.
1844....	" 13-20	" 16	Ditto.
1845....	" 22	" 24	Opposite Fort. (This date rather doubtful.)
1846....	" 7	" 25	Ditto.
1847....	" 9	" 15	Ditto.
1848....	" 21	" 28	Ditto.
1849....	" 18-24	" 27	Ditto.
1850....	" 31	" 28	Ditto.
1851....	" 31	December 9	Ditto.
1852....	" 16	November 8	Ditto.

YORK FACTORY.

Dates of Opening and Closing of Hayes' River at York Factory—Continued.

Year.	River Opened.	River Closed.	Remarks.
1853....	May 26–30	November 9	Opposite Fort.
1854....	" 23	" 16	Ditto.
1855....	" 21–24	" 24	Ditto.
1856....	" 20–22	" 19	Ditto.
1857....	" 14–19	" 17	Ditto.
1858....	" 24	" 24	Ditto.
1859....	" 13	" 16	Ditto.
1860....	" 18	" 19	Ditto.
1861....	" 22–28	" 16	Ditto.
1862....	" 24–29	" 24	Ditto.
1863....	" 22	" 30	Ditto.
1864....	" 19	" 26	Ditto.
1865....	" 16	" 20	Ditto.
1866....	" 14	" 28	Ditto.
1867....	" 23–28	" 24	Ditto.
1868....	" 24–31	" 29	Ditto.
1869....	" 25	" 6	At Mile Sand.
1870....	" 11	" 27	Opposite Fort.
1871....	" 12	" 23	Ditto.
1872....	" 16	" 20	Ditto.
1873....	" 14	" 18	Ditto.
1874....	" 16	" 20	Ditto.
1875....	" 19	" 15	Ditto.
1876....	" 10	" 24	Ditto.
1877....	" 20	" 15–20	Ditto.
1878....	" 15	" 3	Ditto.
1879....	" 11	" 23	Ditto.
1880....	" 26	....	

APPENDIX VIII.

YORK FACTORY.

DATES OF THE ARRIVALS OF THE HUDSON'S BAY COMPANY'S VESSELS AT YORK FACTORY, AND OF THEIR SAILINGS, FOR 93 YEARS, FROM 1789 TO 1880, BOTH INCLUSIVE.

YEAR.	ARRIVED.	SAILED.	REMARKS.
1789......	August 25	September 10	The King George.
1790......	" 20	" 11	Sea Horse.
1791......	September 8	October 4	Sea Horse.
	" 8	September 17	Queen Charlotte.
1792......	August 20	" 17	Sea Horse.
1793......	" 16	" 3	Nimble.
	" 12	" 7	Prince of Wales.
	" 27	" 7	Queen Charlotte.
1794	September 5	" 16	Prince of Wales.
1795......	August 27	" 21	King George.
	" 11	" 21	Queen Charlotte.
1796......	" 20	" 13	King George.
	" 15	" 13	Queen Charlotte.
1797......	" 24	" 16	King George.
	" 6	" 16	Queen Charlotte.
1798......	September 1	" 26	King George.
	" 17	" 26	Queen Charlotte.
1799......	August 30	" 21	King George.
	September 13	" 21	Queen Charlotte.
1800......	" 8	" 24	Prince of Wales.
	" 4	" 24	Queen Charlotte.
1801......	" 10	" 21	King George.
1802......	August 26	" 13	King George.

YORK FACTORY.

Arrivals and Sailings of Vessels—Continued.

Year.	Arrived.	Sailed.	Remarks.
1802......	September 9	September 18	Ceres.
1803......	August 15	" 8	King George.
	" 29	" 3	Ceres.
1804......	" 6	August 27	King George.
1805......	" 28	September 7	" "
1806......	" 18	August 30	" "
1807.....	September 19	October 4	Prince of Wales.
1808......	August 14	September 4	King George.
	" 14	" 4	Eddystone.
1809......	September 8	" 22	King George.
1810......	August 19	" 4	" "
1811......	September 27	October 7	Eddystone.
	" 24	" 6	Edward and Anne.
1812......	August 31	September 14	King George.
1813......	September 26	October 6	Prince of Wales.
1814......	" 2	September 28	" "
1815......	August 28	" 23	" "
	September 1	October 5	H. M. Sloop-of-war Convoy.
1816......	" 22	" 3	The P. of Wales. Wintered at Churchill
1817......	....	....	Britannia.
1818......	August 14	September 8	Prince of Wales.
1819......	" 30	" 27	" "
1820......	" 16	" 9	Eddystone.
1821......	" 22	" 14	Prince of Wales.
1822......	" 10	" 17	" "
1823......	" 15	" 11	" "
1824......	" 20	" 12	" "
1825......	" 16	" 1	" "

YORK FACTORY.

ARRIVALS AND SAILINGS OF VESSELS—Continued.

YEAR.	ARRIVED.	SAILED.	REMARKS.
1826......	September 7	September 22	Prince of Wales.
	" 16	" 17	Camden. From Moose.
1827......	August 25	" 16	Prince of Wales.
1828......	" 16	" 20	Prince Rupert.
1829......	" 12	" 15	" "
	" 9	August 25	Montcalm.
1830......	" 14	September 17	Prince Rupert.
	" 14	" 28	Camden.
1831......	" 28	" 18	"
1832......	" 26	No date.	Prince Rupert.
1833......	September 4	September 27	Ditto. Wintered at Churchill.
1834......	August 23	August 30	Ditto. From Churchill.
	" 25	September 12	Prince George.
1835......	" 23	" 24	Prince Rupert.
	September 14	" 24	Nonpariel.
1836......	" 24	....	Prince Rupert.
	October 7	August 28	Eagle. Wintered at York Factory.
1837......	August 27	September 16	Prince Rupert.
	September 4	" 21	Prince George.
1838.	August 27	" 17	Prince Rupert.
1839......	" 15	" 11	" "
1840.	" 9	" 6	" "
1841......	" 16	" 13	" "
	" 16	" 13	Prince Albert.
1842......	" 16	" 15	Prince Rupert.
1843......	" 9	" 21	" "
1844......	" 11	" 14	" "
1845......	" 10	" 4	"

YORK FACTORY.

Arrivals and Sailings of Vessels—Continued.

Year.	Arrived.	Sailed.	Remarks.
1846......	August 6	September 19	Prince Rupert.
	" 9	" 6	H. M. S. Blenheim.
	" 13	" 6	H. M. S. Crocodile.
1847......	" 25	" 24	The Prince Rupert.
	" 30	" 28	Westminster.
1848......	" 14	" 11	Prince Rupert.
	" 13	August 30	Chartered ship.
	" 25	September 12	" "
1849......	" 13	" 11	The Prince of Wales.
1850......	" 2	August 30	Prince Rupert.
	" 12	September 12	Prince of Wales.
	" 15	August 30	Flora.
	" 24	" 28	George.
1851......	" 12	September 9	Prince Rupert.
1852......	" 15	" 16	" "
	" 25	" 1	Charterod vessel.
1853......	" 15	" 11	The Prince of Wales.
1854......	" 28	" 20	" "
1855......	September 3	" 25	" "
1856......	August 20	" 22	" "
	" 19	" 22	Prince Albert.
1857......	" 9	" 18	Prince of Wales.
	" 26	" 18	Baroness.
	" 12	" 18	Great Britain.
1858......	" 12	" 13	Prince of Wales.
	" 23	" 17	Effort.
1859......	" 26	" 18	Prince of Wales.
1860......	" 16	8	"

YORK FACTORY.

ARRIVALS AND SAILINGS OF VESSELS—Continued.

DATE.	ARRIVED.	SAILED.	REMARKS.
1861......	August 22	September 9	Prince of Wales.
	" 23	August 31	Sir Colin Campbell.
1862......	" 13	S ptember 9	Prince of Wales.
1863......	" 28	" 17	" "
1864......	" 23	" 20	Ocean Nymph.
1864....	" 28		The Prince of Wales. Wintered at York Factory, and left with
1865....	" 22	October 2	The Prince Rupert.
1866......	September 2	" 4	The Prince Rupert.
1867......	August 12	September 17	" "
1868......	" 25	" 20	" "
1869......	" 20	" 26	" "
1870......	" 22	" 18	" "
	September 2	" 9	Ocean Nymph.
1871......	August 8	" 20	Prince Rupert.
	" 11	" 2	Ocean Nymph.
1872......	" 17	" 22	Prince Rupert.
	September 23	" 21	Schooner Walrus { New vessel for York Factory.
1873......	August 10	" 20	Prince Rupert.
1874......	September 9	" 20	Schooner Mink, for Moose.
			Walrus, for London.
1875......	" 15	" 22	Ocean Nymph { Called at Churchill before making York.
1876......	" 12	" 21	" " " "
1877......	" 12	" 25	" " " "
1878......	August 22	August 29	" " " "
1879......	" 24	September 1	" " " "
1880......	September 4	" 13	" " " "

APPENDIX IX.

MOOSE FACTORY.

Seasonal or Periodic Events.

1878—January 19	Slight rain.
February 16	Snow in woods ten inches deep.
March 15	Snow-birds seen.
April 5	First goose. First robins seen.
April 14	Blackbirds seen.
April 30	Frogs heard. First thunderstorm. River open.
May 1	Mosquitoes and swallows seen.
May 19	Garden dug. Some seed sown.
May 21	Potatoes planted.
May 23	Swallows appeared in force.
June 4	Last snow of season.
June 28	First lightning.
October 15	First snow of season.
November 2	River frozen over.
November 4	Snow in woods five inches deep.
December 25	Thirty inches of snow in woods.
1879—March 24	Snow-birds seen.
April 23	First thunderstorm.
May 4	Sufficient snow in woods for sleighing.
June 15	Last snow of season.
July 24	Potatoes nipped with frost.
September 13	First snow of season.
1880—January 9	Rain, 2 to 6 p.m.
April 14	Thunderstorm. St. Elmo's fires seen on several projecting points, 10 to 12 p.m.
June 2	Last snow of season.

APPENDIX X.

MOOSE FACTORY.

DATES OF THE ARRIVALS OF THE HUDSON'S BAY COMPANY'S VESSELS AT MOOSE FACTORY, AND OF THEIR SAILINGS, FOR 147 YEARS—1735 TO 1880, BOTH INCLUSIVE.

YEAR.	ARRIVED.	SAILED.	YEAR.	ARRIVED.	SAILED.
1735....	August 3	August 30	1757....	August 24	September 1
1736....	" 15	" 28	1758....	September 16	October 2
1737....	" 7	" 24	1759....	" 4	September 11
1739....	" 5	" 19	1760....	August 26	" 16
1740....	" 4	" 20	1761....	" 9	" 5
1741....	" 26	September 1	1762....	September 2	" 12
1742....	July 27	August 4	1763....	August 29	" 5
1743....	August 3	" 14	1764....	" 21	August 28
1744....	" 12	" 21	1765....	September 4	September 20
1745....	July 21	" 29	1766....	August 2	" 6
1746....	August 17	" 27	1767....	September 1	" 16
1747....	" 12	" 22	1768....	" 2	" 6
1748....	" 20	" 29	1769....	" 1	" 8
1749....	July 27	" 6	1770....	August 2	" 11
1750....	August 27	September 4	1771....	" 25	" 14
1751....	" 3	August 10	1772....	September 5	" 11
1752....	" 13	" 21	1773....	August 26	" 2
1753....	September 4	September 11	1774....	September 5	" 21
1754....	" 2	" 15	1775....	August 23	" 6
1755....	August 28	" 7	1776....	" 29	" 17
1756....	September 16	" 23	1777....	September 13	" 26

Arrivals and Sailings of Vessels—Continued.

Year.	Arrived.	Sailed.	Year.	Arrived.	Sailed.
1778....	August 22	September 17	1805....	August 17	September 13
1779.. }	Did not reach Moose on account of ice. Went to Churchill instead		1806....	" 10	" 13
1780....	September 5	September 29	1807....	September 4	" 24
1781....	August 28	" 22	1808....	August 14	" 21
1782....	" 24	" 25	1809....	August 21	September 30
1783....	September 17	October 5	1810....	" 10	" 24
1784....	" 4	September 20	1811....	September 25	October 10
1785....	" 8	" 23	1812....	August 26	September 28
1786....	August 16	" 9	1813....	September 4	" 27
1787....	" 27	" 10	1814....	" 2	" 21
1788....	" 16	" 10	1815....	August 23	" 24
1789....	" 15	" 14	1816....	September 20	October 4
1790....	" 29	" 28	1817....	August 26	September 14
1791....	September 7	" 28	1818....	" 17	" 11
1792....	August 17	" 16	1819....	" 29	" 19
1793....	" 22	" 21	1820....	" 6	" 11
1794....	" 18	" 13	1821....	" 19	" 16
1795....	" 29	" 26	1822....	" 15	" 12
1796....	" 20	" 21	1823....	" 18	" 16
1797....	" 28	" 23	1824....	" 29	" 22
1798....	September 6	" 30	1825....	" 16	" 18
1799....	August 31	October 1	1826....	" 30	" 10
1800....	September 8	" 8	1827....	" 11	" 9
1801....	August 23	September 14	1828....	" 29	" 17
1802....	" 19	" 10	1829....	" 31	" 16
1803....	" 26	" 11	1830....	" 30	" 22
1804....	" 5	" 21	1831....	" 27	" 27

ARRIVALS AND SAILINGS OF VESSELS—Continued.

YEAR.	ARRIVED.	SAILED.	YEAR.	ARRIVED.	SAILED.
1832....	August 25	September 20	1859....	September 2	" 16
1833..	September 7 Wintered at Charlton Island.	" 24	1860....	August 22	" 9
1834....	August 25	September 8	1861....	" 31	" 19
1835....	" 18	" 7	1862....	" 29	" 29
1836....	September 2	" 18	1863....	" 28	" 26
1837....	August 27	" 13	1864....	....	....
1838....	September 5	" 19	1865....	September 13	September 28
1839....	August 14	" 11	1866....	August 24	" 23
1840....	" 12	August 30	1867....	" 18	" 18
1841....	" 30	September 12	1868....	" 26	" 14
1842....	" 29	" 10	1869....	September 8	" 26
1843....	September 14	October 3	1870....	August 24	" 11
1844....	August 28	September 10	1871....	" 27	" 18
1845....	September 8	" 24	1872....	" 20	" 10
1846....	August 9	August 31	1873..	August 21 Wintered at Charlton Island.	" 19
1847....	" 24	September 9	1874....	August 24	September 13
1848....	" 10	August 31	1875....	September 10	" 26
1849....	" 16	September 9	1876....	" 4	" 20
1850....	" 17	" 7	1877....	August 20	" 8
1851....	" 25	" 10	1878....	" 11	" 4
1852....	" 15	" 8	1879....	" 23	" 12
1853....	" 22	" 17	1880....	" 28	" 10
1854....	September 3	" 21			
1855....	August 23	" 22			
1856....	" 17	" 7			
1857....	" 16	" 8			
1858....	" 18	" 8			

APPENDIX XI.

STATISTICS OF THE WEATHER FOR TWO YEARS AT YORK AND MOOSE FACTORIES, HUDSON'S BAY.

Observatory stations have been established for a few years at York and Moose Factories, in connection with the Government Meteorological Office in Toronto. As these afford complete and accurate statistics of the weather at two points on Hudson's Bay, about seven hundred miles apart, a summary of the results of the observations for two years, from each station, is herewith given, as being among the best means of illustrating the climate of the region to which this report refers. We are indebted to Professor Charles Carpmael, Director of the Meteorological Service, for copies of these returns.

YORK FACTORY.

Abstract of Observations during the year 1876 *at York Factory, H.B. Latitude,* 57° 0′ *N.; Longitude,* 92° 26′ *W. Mr. Wm. Wood, Observer.*

	TEMPERATURE.									Average amount of cloud.	NO. OF WINDS FROM (AT HOURS OF OBSERVATION.)										RAIN.		SNOW.		No. of fogs.	No. of thunder-storms.	No. of auroras.
	7 a.m.	2 p.m.	9 p.m.	Mean.	Mean of highest.	Mean of lowest.	Absolutely highest.	Absolutely lowest.	Greatest range in 24 hours.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	Av'rage velocity of wind in miles.	Amount of	Days of	Amount of	Days of			
	°	°	°	°	°	°	°	°	°												in.		in.				
January	-19.58	-14.03	-15.93	-16.37	-5.15	-24.30	22.0	-48 0	30.0	4.6	12	0	8	5	4	17	7	23	17	7.41	0.00	0	11.3	20	0	..	15
February	-25.57	-15.55	-19.83	-20.31	-10.46	-29.27	17.0	-53.0	37.0	4.5	5	6	9	3	8	12	14	21	9	8.46	0.00	0	6.5	14	0	....	13
March	-19.55	-3.52	-11.79	-11.66	-1.13	-26.10	24.0	-46.0	52.0	3.3	17	15	0	0	8	6	9	23	15	5.86	0.00	0	6.7	11	0	....	13
April	15.75	27.33	19.80	20.67	30.5[illegible]	9.36	54.0	-16.5	39.0	6.1	20	13	13	10	10	3	11	5	5	9.55	0.04	1	6.1	15	1	.	7
May	35.79	42.92	36.08	38.26	48.11	29.55	78.0	15 5	48.5	4.9	32	24	7	2	10	9	5	3	1	7.96	0.25	1	1.0	4	1	1	7
June	45.65	53.37	48.55	49.05	59.78	37.47	79.0	27.0	40.0	4.5	12	15	19	14	18	2	10	9	1	9.13	7.70	7	....	...	1	1	0
July	53.63	61.65	55.48	56.56	67.24	47.08	99.0	39.5	41.0	5.2	17	10	16	5	23	1	12	8	1	12.30	17.10	19	....	...	5	2	8
August	52.85	61.32	54.19	55.63	66.21	46.05	86.0	29.0	41.0	4.6	27	8	6	1	19	9	19	4	0	15.19	22.70	16	.....	....	1	1	4
September	42.56	51.10	44.85	45.84	53.66	38.61	74.0	28.0	82 0	6.9	17	7	18	8	14	5	3	18	0	14.59	9.40	17	.....	....	1	3	6
October	25.51	28.75	26.01	26.57	30.65	22.21	42.0	8.0	21.5	7.4	19	12	10	6	13	0	4	29	0	16.80	1.97	5	5.8	18	7	...	5
November	0.76	4.88	0.03	1.42	9.93	-6.20	35.0	-35.5	37.5	5.2	28	0	1	0	13	12	12	24	0	12.71	0.00	0	20.1	17	1	....	8
December	-12.69	-9.55	-13.21	-12.16	-4.72	-20.19	24.0	-36.0	31.0	5.2	23	0	0	0	20	20	17	13	0	17.07	0.00	0	8.4	17	0	....	15
	16.36	24.06	18.69	19.45	......	.....	99	-53.0	48.5	5.2	229	110	107	44	160	96	123	180	49	11.42	59.16	66	65.9	116	18	8	96

YORK FACTORY.

Abstract of Observations during the year 1878 *at York Factory, H.B. Latitude,* 57° 0′ *N. Longitude,* 92° 26′ *W. Mr. Wm. Wood, Observer.*

	TEMPERATURE.									Average amount of cloud.	NO. OF WINDS FROM									Av'rage velocity of wind in miles.	RAIN.		SNOW.		No. of fogs.	No. of thunder-storms.	No. of Auroras.
	7 a.m.	2 p.m.	9 p.m.	Mean.	Mean of highest.	Mean of lowest.	Absolutely highest.	Absolutely lowest.	Greatest range in 24 hours.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.		Amount of	Days of	Amount of	Days of			
	°	°	°	°	°	°	°	°	°												in.		in.				
January	......	......	......	-6.92	......	......	26.5	-33.0	......	...	...	...	...	...	...	...	...	...	...	11.6	0.00	0	4.9	6	....	0	16
February	......	......	......	2.78	......	......	40.0	-27.0	......	...	...	...	...	...	...	...	...	...	...	8.81	0.00	0	5.7	10	....	0	11
March	......	......	......	10.24	......	......	36.0	-18.5	33.0	6.5	7	25	14	10	6	3	6	16	0	10.9	0.00	0	17.9	22	....	0	12
April	21.42	32.83	26.20	26.66	36.58	17.68	53.5	3.5	30.0	4.4	14	24	8	5	11	10	7	11	0	9.5	0.25	3	1.6	9	1	0	7
May	29.90	38.08	32.03	33.11	42.34	25.94	75.0	10.5	44.0	5.6	27	26	7	2	7	5	7	12	0	12.1	1.91	11	3.8	6	....	0	3
June	54.43	78.38	63.38	64.89	87.48	48.98	109.5	25.0	49.5	4.2	16	16	20	15	7	5	10	1	0	14.3	10.50	11	......	......	....	6	5
July	62.48	83.63	74.55	73.80	91.73	56.73	106.0	46.0	46.0	3.9	11	27	21	10	9	5	7	3	0	13.2	14.80	15	......	......	1	7	3
August	53.03	68.20	57.00	58.81	75.05	47.84	91.5	38.0	41.5	3.2	4	22	18	13	13	7	10	6	0	11.9	4.90	9	......	......	....	4	6
September	34.55	40.92	37.28	37.50	42.69	31.94	60.2	26.0	22.8	5.4	28	9	3	0	3	8	17	22	0	12.2	14.10	12	2.7	10	1	0	7
October	19.44	24.97	21.61	21.91	27.64	15.77	38.2	-2.0	26.0	5.6	24	15	9	1	5	1	10	28	0	12.0	0.00	0	24.1	19	....	0	10
November	14.58	21.32	17.62	17.78	23.75	10.53	35.0	-15.0	28.5	6.4	13	2	4	2	24	12	13	20	0	10.5	0.20	1	6.2	16	1	0	6
December	-9.65	-3.14	-6.61	-6.50	-0.08	-14.45	29.0	-28.0	29.0	6.0	13	0	2	4	5	10	19	40	0	11.2	0.00	0	4.3	20	....	0	4
	......	......	......	27.84	......		106.0	-33.0	......	...	...	...	...	...	...	...	...	...	...	......	46.65	62	71.2	118	4	17	90

YORK FACTORY.

Mean Daily Temperature from Observations at 7 a.m., 2 and 9 p.m., 1876.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°	°	°	°	°	°	°
1......	-14.1	-31.7	-7.5	22.5	34.0	36.7	52.5	67.9	49.5	36.9	27.0	-17.9
2......	-3.1	-26.1	-6.0	13.6	29.5	37.0	64.8	72.4	45.4	33.4	4.6	9.6
3......	-30.5	-47.6	-25.4	34.6	27.2	53.1	44.9	71.1	48.9	25.1	-3.3	16.8
4......	-30.0	-37.0	-30.3	20.8	28.0	39.8	54.5	56.0	52.7	21.2	1.0	13.5
5......	-17.0	-20.7	-27.5	8.1	40.3	33.4	62.3	50.5	42.1	26.2	0.0	13.3
6......	-5.4	-35.6	-20.5	-2.9	44.7	46.5	58.8	58.2	46.0	23.0	13.7	-3.6
7......	-15.8	-33.5	-13.1	-7.2	45.8	42.4	56.5	65.7	41.0	20.8	36.2	-17.9
8......	-19.5	-22.7	3.6	4.9	38.0	46.8	50.1	71.3	42.9	24.2	20.4	-27.0
9......	-13.4	-24.7	-21.2	12.1	33.7	62.8	47.5	52.0	53.0	26.5	8.5	-31.6
10......	-22.3	-13.0	-21.6	25.4	31.5	67.9	55.8	44.0	56.4	23.0	19.9	-8.0
11......	-14.3	-7.5	-24.3	25.1	34.2	48.1	54.5	42.5	59.6	19.4	-7.4	-4.5
12......	-17.1	-14.7	-17.7	31.6	26.7	46.3	57.3	45.0	50.0	18.6	-3.1	-22.4
13......	-9.1	-20.6	-13.3	36.0	27.0	40.5	54.5	56.6	42.4	18.1	-11.5	-31.4
14......	-5.1	-12.9	-26.3	23.9	33.7	48.1	55.1	60.5	38.4	15.4	-16.3	-17.7
15......	-3.0	-7.2	-26.6	18.7	46.0	39.0	57.6	54.4	37.9	22.9	-12.9	-30.1
16......	6.1	-11.5	-23.1	13.7	56.2	38.3	52.4	53.1	45.5	24.4	-3.5	-28.4
17......	14.5	-5.1	-14.8	12.1	45.3	49.7	52.0	57.8	45.6	31.4	-14.6	-27.4
18......	-0.1	-4.0	-10.0	10.3	42.7	56.6	55.9	48.5	43.0	28.0	-2.9	-24.5
19......	-14.1	-22.5	-15.0	20.8	53.3	56.3	47.4	48.8	48.0	33.1	13.9	-30.4
20......	-14.3	-20.9	5.5	31.2	39.8	39.5	45.5	56.5	53.4	32.9	18.6	-32.3
21......	-11.0	-19.0	9.5	33.6	31.0	42.0	49.5	66.1	59.7	34.4	19.8	-19.6
22......	-13.6	-26.5	-8.8	33.3	48.2	63.8	53.6	70.5	54.7	33.4	8.4	-0.4
23......	-25.5	-27.8	-2.4	51.2	32.2	73.0	55.4	55.9	50.3	34.0	8.7	-3.7
24......	-22.0	-26.1	-6.9	19.0	38.5	68.0	65.9	44.2	46.5	31.3	7.1	-0.8
25......	-20.5	-33.9	-15.0	34.2	57.3	44.4	66.4	43.5	42.4	25.4	1.1	5.5
26......	-9.1	-27.0	-14.2	40.8	40.0	46.3	67.8	47.3	42.9	14.4	-4.1	3.5
27......	-35.3	-7.9	-4.7	30.1	34.8	45.4	58.8	46.1	41.5	21.4	-20.4	-1.0
28......	-32.4	-0.9	-5.6	10.0	34.5	52.0	53.1	58.6	34.3	29.8	-19.0	-10.5
29......	-42.4	-11.6	0.0	13.3	50.3	60.5	56.3	58.9	32.7	34.0	-20.2	-17.4
30......	-30.1	......	2.8	18.7	32.5	53.8	69.3	54.5	31.6	32.4	-17.9	-6.5
31......	-37.5	......	16.4	......	29.3	......	77.0	48.9	......	29.4	......	13.8

YORK FACTORY.

Highest and Lowest Temperature for each day during the year 1876.

	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1........	......	......	-28.0	-45.0	-1.0	-26.0	30.0	-9.0	13.0	15.5	51.0	27.0	62.0	41.0	78.0	62.0	59.0	43.0	42.0	28.0	28.0	24.0	-12.0	-29.0
2........	......	......	-21.5	-35.0	9.0	-5.0	40.0	2.0	35.0	26.0	43.0	28.5	72.0	52.0	80.0	61.0	55.0	41.0	38.0	32.0	28.0	1.0	13.0	-16.0
3........	......	......	-20.0	-48.5	12.0	-32.0	24.0	20.0	31.0	24.5	62.5	34.0	65.0	40.0	80.0	61.0	58.0	38.5	32.0	23.0	6.0	-8.0	18.0	3.0
4........	......	......	-38.0	-53.0	-22.0	-32.0	44.0	15.0	33.0	24.0	72.0	33.0	64.0	40.0	67.0	49.0	64.5	40.5	25.0	20.0	10.0	-10.0	23.0	9.0
5........	......	......	-13.0	-38.0	-24.0	-46.0	27.5	3.0	50.0	33.0	42.0	29.5	72.0	42.0	56.0	42.0	46.0	39.0	30.0	18.5	8.5	-7.0	24.0	6.0
6........	......	......	-11.5	-40.0	-15.0	-46.0	12.0	3.0	55.0	33.0	54.0	32.0	65.0	54.0	67.0	52.5	52.0	38.0	26.0	17.0	18.0	0.0	6.5	-10.0
7........	......	......	-23.5	-45.5	-8.0	-29.0	4.0	-13.0	57.0	35.0	67.5	34.5	65.5	48.5	73.0	52.0	46.5	40.5	23.0	16.0	32.0	17.0	-6.5	-25.0
8........	......	......	-14.0	-35.0	2.5	-28.0	0.0	-16.5	58.0	33.5	55.0	31.0	55.5	40.0	84.0	65.0	50.0	39.0	26.0	17.0	35.0	16.5	-20.0	-31.0
9........	......	......	-14.0	-37.0	10.0	-22.0	13.5	-12.5	38.0	30.0	74.0	44.0	50.0	40.0	67.0	44.0	62.0	38.0	31.0	22.0	16.5	4.0	-27.0	-35.0
10........	......	......	-10.0	-26.0	-19.0	-32.0	28.0	9.0	36.0	27.0	77.0	52.0	62.0	51.5	46.0	42.0	63.0	46.0	28.0	18.5	36.0	8.5	-2.0	-33.0
11........	......	......	-3.0	-12.0	-12.0	-31.0	37.0	16.5	38.0	29.5	69.0	40.0	65.0	50.0	48.0	39.0	74.0	45.0	27.0	15.0	9.0	-11.0	6.5	-12.0
12........	-1.0	-22.5	-5.0	-14.0	-19.0	-36.0	28.0	24.0	31.0	24.5	51.0	34.5	68.5	49.5	50.0	39.0	72.0	40.0	20.0	9.5	5.0	-12.5	-4.0	-29.0
13........	-1.0	-22.0	-6.0	-28.0	-5.0	-34.0	40.5	28.0	32.0	22.5	51.0	34.5	61.0	52.0	76.0	40.0	51.0	35.0	20.0	16.0	-5.0	-16.5	-20.0	-36.0
14........	-6.0	-27.0	-9.5	-25.0	4.0	-32.0	42.0	20.0	43.0	25.0	56.0	29.0	60.0	48.0	70.0	40.0	42.0	32.0	19.0	14.5	-9.0	-22.0	-13.0	-23.0

YORK FACTORY.

Highest and Lowest Temperature for each day during the year 1876.—Continued.

	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
15........	5.0	-7.5	-4.0	-21.5	-13.0	-32.0	35.0	13.0	56.0	28.5	52.0	34.0	60.0	48.5	71.0	44.0	41.0	33.0	36.0	14.5	-7.5	-24.0	-13.0	-35.0
16........	9.0	-14.0	-3.0	-25.0	-19.0	-37.0	23.0	12.0	63.0	40.5	42.5	31.0	75.0	44.5	61.0	46.0	53.0	38.0	30.0	14.0	6.0	-14.0	-20.0	-32.5
17........	19.0	6.0	10.0	-27.0	-8.0	-35.0	20.0	9.0	57.0	38.5	59.0	34.5	72.0	44.0	76.0	45.5	53.0	28.0	36.5	26.0	-6.0	-21.0	-24.0	-35.0
18........	22.0	-2.0	17.0	-7.0	0.0	-30.0	20.0	9.5	53.0	31.0	68.5	40.5	63.0	49.0	57.0	40.5	52.0	41.0	35.0	27.0	0.0	-14.5	-19.0	-28.0
19........	2.0	-23.0	15.0	-20.0	10.0	-25.0	21.0	-1.0	67.0	44.0	69.0	40.5	56.0	43.0	54.0	37.5	52.0	37.5	35.0	27.0	16.0	-3.0	-23.0	-38.0
20........	-2.0	-23.0	16.0	-38.0	-6.0	-24.0	32.0	3.0	52.0	32.0	51.0	36.0	50.0	40.5	70.0	39.0	60.0	49.5	34.0	32.0	21.0	12.0	-26.0	-36.0
21........	-4.0	-18.0	-9.0	-18.0	14.0	-18.5	36.5	25.5	40.0	28.0	49.0	35.0	51.0	41.5	80.0	39.0	68.0	46.0	37.0	33.0	23.0	17.5	-13.0	-36.0
22........	-7.0	-17.5	-10.0	-33.0	18.0	-3.0	43.0	20.0	72.0	28.5	69.0	46.0	73.0	42.5	86.0	58.5	69.0	49.5	37.5	32.5	17.5	5.0	3.0	-13.0
23........	-3.0	-22.0	-23.0	-29.0	9.0	-30.0	47.0	23.0	43.0	26.5	79.0	52.0	60.0	39.5	71.0	50.0	62.5	41.5	36.0	32.0	11.0	2.0	-2.0	-14.0
24........	-15.0	-38.0	-21.0	-34.0	24.0	-28.0	48.0	12.0	58.0	25.0	74.0	58.0	91.0	50.0	55.0	42.0	55.0	38.0	34.0	31.0	21.0	1.0	3.0	-14.0
25........	-13.0	-25.0	-24.0	-35.0	10.0	-20.0	28.0	10.0	78.0	45.0	50.0	38.0	82.0	57.5	55.0	41.5	48.0	40.5	31.0	21.5	8.0	-18.0	8.0	0.0
26........	-6.0	-26.0	-21.0	-46.0	-9.0	-25.0	51.0	18.0	48.0	33.0	50.0	42.0	87.0	56.0	57.0	38.0	47.5	34.0	21.5	8.0	20.0	-17.5	10.0	1.0
27........	-4.0	-34.0	-1.0	-22.0	-6.0	-21.0	53.0	35.0	44.0	31.0	50.8	37.0	65.0	54.5	60.0	29.0	43.5	36.0	26.8	9.5	-14.0	-20.0	8.0	-6.0
28........	-25.0	-43.0	1.0	-5.0	2.0	-14.5	54.0	8.5	41.0	27.0	59.0	38.0	65.0	47.5	68.5	42.0	41.5	31.0	32.5	22.0	-9.0	-26.0	-1.0	-16.0
29........	-23.5	-12.0	2.5	-20.5	7.0	-14.5	18.0	4.0	61.0	27.0	74.0	34.0	68.0	48.0	67.0	51.0	36.0	31.0	37.0	32.5	-14.0	-25.5	-14.0	-22.0
30........	-29.5	-18.0	.....	.....	9.5	-0.5	30.0	7.0	50.5	28.5	72.0	44.0	85.0	45.0	63.0	48.0	33.0	28.5	33.0	32.0	-13.0	25.0	-2.0	16.0
31........	20.0	-17.5	.....	.....	15.0	11.0	.....	.....	33.0	26.0	.....	.....	99.0	64.5	54.0	47.5	.....	.....	32.0	28.0	.....	.....	-5.0	-19.5

YORK FACTORY.

Mean Daily Temperature from Observations at 7 a.m., 2 and 9 p.m., 1878.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°	°	°	°	°	°	°
1	......	......	......	23 8	32.3	29.9	74.1	60.5	47.0	30.1	6.6	21.1
2	......	......	......	36.0	32.6	39.5	76.4	60.3	45.4	29.4	7.0	11.8
3	......	......	2.3	43.2	33.7	31.9	79.5	60.0	45.9	28.5	-6.1	3.1
4	......	......	0.4	40.0	30.3	45.8	78.0	56.7	46.5	29.8	6.3	4.2
5	......	......	1.1	13.8	31.7	66.9	82.9	58.6	43.3	26.7	15.1	-5.9
6	......	......	-5.2	15.6	34.0	70.5	84.5	59.9	39.5	26.9	25.7	-18.6
7	......	......	-5.5	17.5	35.4	70.5	83.9	60.4	37.4	26.4	22.0	-19.3
8	......	......	1.6	21.0	22.8	62.1	78.6	57.5	42.4	25.0	22.1	-13.6
9	......	......	18.5	20.7	31.5	73.1	78.6	56.8	38.1	22.9	30.0	-0.6
10	......	......	17.1	24.6	22.4	68.2	76.1	57.5	36.9	24.1	26.1	[illegible]
11	......	......	18.0	25.8	23.2	67.4	82.9	60.1	35.9	28.5	23.1	-14.6
12	......	......	15.9	20.6	19.8	70.6	74.4	57.6	35.6	23-9	17.3	8.6
13	......	......	16.8	20.2	23.2	69.1	67.9	56.9	34.9	27.0	17.7	-2.9
14	......	......	23.6	21.0	26.3	70.1	78.5	56.9	34.9	30.6	15.6	-5.1
15	......	......	18.1	22.1	32.5	72.8	79.0	56.5	36.6	31.8	15.6	-8.4
16	......	......	16.0	22.0	34.0	68.7	83.2	56.5	36.1	29.4	28.8	-9.3
17	......	......	1.1	22.8	34.2	68.3	82.6	60.1	37.6	30.7	32.9	-1.9
18	......	......	11.7	25.0	32.5	71.1	84 0	56.2	38.9	30.6	22.4	-13.1
19	......	......	8.9	25.1	23.4	68.9	80.1	58.5	37.5	32.3	13.5	-13.9
20	......	......	5.4	24.6	39.1	75.9	85.3	59.5	40.0	18.5	13.2	-13.2
21	......	......	4.4	24.7	45.3	73.9	72.0	60.0	39.1	14.6	25.0	-7.5
22	......	......	-0.3	35.5	42.5	72 7	71.2	71.3	34.4	15.0	22.3	-13.6
23	......	......	-2.6	33.5	46.2	61.0	65.8	65.5	32.6	16.0	19.5	-11.6
24	......	......	13.1	35.1	36.8	58.3	51.9	59.7	33.6	8.7	21.2	-7.6
25	......	......	14.4	31.9	35.1	59.1	61.6	58.3	33.1	12.1	21.8	-8.1
26	......	......	6.9	31.4	42.0	64.4	64.5	54.9	[illegible]	13.1	21.1	-1.3
27	......	......	13 4	29.1	42.5	74.1	66.7	54.5	31.1	10.6	11.0	-5.7
28	......	......	24.5	33.0	38.9	76 4	64.8	55.0	31.2	7.1	12.5	-13.0
29	......	......	15.7	32.1	32.5	72.4	59.4	60.1	30.4	13.5	5.9	-4.1
30	......	......	20.0	33.0	30.6	72.4	58 9	58.2	37.1	9.6	18.2	-15.6
31	......	......	21.9	......	30.6	......	60.6	58.5	......	10.6	......	-18.1

YORK FACTORY.

Highest and Lowest Temperatures for each day during the year 1878.

	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1	......	......	......	......	......	......	39.0	15.5	43.5	27.0	34.0	25.0	99.0	60.5	70.5	50.0	60.2	37.9	38.2	27.0	15.0	0.5	29.0	14.0
2	......	......	......	......	......	......	41.0	20.0	40.0	28.0	61.5	28.0	98.0	62.0	76.0	51.5	57.7	35.9	32.0	26.0	13.0	2.0	17.0	8.0
3	......	......	......	......	8.0	-5.0	49.5	28.0	46.0	27.0	35.0	29.0	102.0	58.5	78.0	50.0	53.8	33.9	31.5	24.0	2.0	-10.5	9.0	-5.0
4	......	......	......	......	8.5	-5.0	51.0	34.0	38.0	25.0	67.0	28.5	96.5	59.0	68.0	50.0	52.8	30.9	34.0	24.0	13.5	-15.0	8.0	-3.0
5	......	......	......	......	7.0	-17.5	37.0	8.0	34.0	23.0	90.0	41.5	106.0	60.0	67.0	49.0	54.8	39.4	30.0	23.5	21.0	5.0	7.0	-15.0
6	......	......	......	......	4.5	-10.0	26.0	3.5	38.0	26.0	96.0	47.5	101.0	63.0	69.0	49.5	49.8	28.9	29.0	25.0	27.0	14.0	-7.0	-24.5
7	......	......	......	......	-0.5	-18.5	26.0	3.5	37.5	28.0	92.0	57.0	98.0	61.0	71.0	50.5	45.8	30.9	28.5	21.0	26.0	20.0	-17.0	-25.0
8	......	......	......	......	8.0	-4.0	29.5	6.0	37.0	27.5	73.0	54.5	96.5	57.0	70.0	51.5	50.8	35.9	27.5	20.5	28.0	8.5	-7.5	-25.5
9	......	......	......	......	30.5	0.0	30.0	12.0	36.0	26.0	94.0	50.5	98.5	56.0	78.0	52.0	46.8	33.9	26.0	20.0	33.0	24.0	3.0	-12.0
10	......	......	......	......	29.5	2.0	36.0	10.0	31.0	18.0	90.5	48.0	99.0	59.5	72.5	51.0	39.8	32.9	27.0	19.0	31.5	15.0	8.5	-6.0
11	......	......	......	......	28.0	-2.0	34.0	13.0	30.0	10.5	91.0	50.5	102.0	60.0	74.0	52.0	39.3	31.9	26.0	18.0	30.0	18.0	1.0	-18.5
12	......	......	......	......	27.0	6.0	31.0	12.0	25.0	17.0	92.5	54.0	97.0	56.0	73.5	50.5	38.8	30.9	26.5	18.5	26.0	13.0	10.0	-19.0
13	......	......	......	......	25.5	7.5	28.0	11.5	27.0	15.0	97.5	54.0	80.0	63.0	76.0	48.5	37.8	31.9	31.5	21.0	20.0	13.5	3.0	-8.0
14	......	......	......	......	34.0	16.0	32.0	12.0	32.0	20.0	99.5	55.5	98.0	60.0	71.5	49.0	38.3	32.4	35.0	24.0	19.5	18.0	2.0	-9.0

15	...	...	...	...	28.0	15.0	31.0	16.0	41.0	24.0	100.5	57.0	99.0	61.5	72.0	49.5	39.8	32.4	36.5	26.5	20.0	12.0	-4.5	-18.0
16	...	...	...	...	23.0	1.5	30.0	15.5	44.0	25.5	86.5	50.0	101.0	58.5	70.5	50.0	40.3	32.9	31.0	26.0	33.0	17.0	-1.0	-19.5
17	...	...	...	...	18.0	-8.0	37.5	15.0	46.0	26.0	90.5	53.0	101.5	61.0	76.0	50.5	43.8	34.9	34.5	25.5	35.0	28.0	4.0	-12.0
18	...	...	...	...	29.0	-0.5	36.0	16.0	42.0	28.0	94.0	56.5	104.0	64.5	76.0	45.0	44.8	34.9	36.0	24.0	33.0	20.0	0.5	-17.0
19	...	...	...	...	22.0	0.0	29.0	17.5	32.0	18.0	97.5	50.5	99.5	62.0	83.0	44.5	42.8	33.9	37.0	28.0	23.0	11.0	-7.5	-27.0
20	...	...	...	...	10.0	-1.0	31.0	20.0	66.5	20.0	100.5	54.5	103.0	63.0	82.5	43.5	45.8	34.4	31.0	10.0	20.0	7.0	-9.0	-23.0
21	...	...	...	...	10.5	-1.5	33.5	18.5	75.0	31.0	98.5	52.5	91.0	56.0	84.5	52.0	45.3	37.9	29.5	8.0	28.0	12.0	-2.0	-10.0
22	...	...	...	...	9.0	-2.0	48.0	18.0	58.0	32.0	96.5	57.0	86.0	55.5	91.5	50.0	37.8	31.9	26.0	6.0	27.0	16.0	-9.0	-20.5
23	...	...	...	...	4.0	-6.5	53.5	26.0	62.0	33.0	95.5	50.0	81.0	54.0	86.0	58.5	36.0	29.9	31.0	9.0	26.5	14.0	-7.5	-19.0
24	...	...	...	...	23.0	-7.0	47.0	28.0	46.0	32.0	90.0	40.5	68.0	47.0	78.0	48.5	35.5	30.4	24.0	-2.0	28.5	14.0	-4.0	-16.0
25	...	...	...	...	31.0	-2.0	42.0	26.5	40.5	31.0	89.0	42.5	76.5	48.0	74.0	40.5	35.0	29.4	19.0	2.0	27.0	15.0	-6.0	-12.5
26	...	...	...	...	18.0	-0.5	38.0	24.5	54.0	32.0	80.0	46.5	74.0	50.0	73.0	38.0	34.0	28.9	20.5	7.0	29.0	10.0	0.0	-9.0
27	...	...	...	...	26.0	-5.0	37.0	22.0	60.5	34.0	97.0	58.5	90.5	49.5	71.0	39.0	33.0	27.9	18.0	3.5	21.0	8.0	0.0	-7.0
28	...	...	...	...	34.0	15.0	46.0	22.5	48.0	35.0	99.5	59.0	76.5	48.0	67.0	40.5	34.0	27.0	12.0	-2.0	20.0	7.0	-6.5	-19.0
29	...	...	...	...	23.0	13.0	44.0	24.0	37.0	31.0	98.0	58.0	78.0	49.5	76.0	41.0	33.0	26.0	18.0	4.0	11.0	1.0	2.0	-16.0
30	...	...	...	...	28.0	10.5	43.0	26.0	32.0	26.5	97.5	60.0	71.5	46.0	78.5	44.0	39.3	28.0	14.0	6.0	28.0	2.0	-8.0	-26.0
31	...	...	...	...	30.0	14.5	...	...	33.0	27.0	...	...	71.0	49.0	72.0	43.0	...	...	16.0	2.0	...	...	-10.0	-28.0

MOOSE FACTORY.

Abstract of Observations during the year 1878 *at Moose Factory, James' Bay. Latitude,* 51° 16′ *N.; Longitude,* 80° 56′ *W. By J. R. Nason, Esq.*

	TEMPERATURE.									Average amount of cloud.	NO. OF WINDS FROM (AT HOURS OF OBSERVATION.)									Average force of wind.	RAIN.		SNOW.		No. of fogs.	No. of thunder-storms.	No. of Auroras.
	9 a.m. *	2 p.m.	7 p.m. *	Mean.	Mean of highest.	Mean of lowest.	Absolutely highest.	Absolutely lowest.	Greatest range in 24 hours.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.		Amount of	Days of	Amount of	Days of			
	°	°	°	°	°	°	°	°	°												In.		In.				
January	-5.66	3.23	-0.78	-1.07	10.35	-9.45	32.7	-35.9	46.6	5.3	5	3	5	1	7	26	14	24	[illegible]	2.1	R.	1	0.3	9	....	....	7
February	9.62	17.41	12.92	13.31	21.71	0.82	42.5	-21.7	37.5	4.7	11	13	1	0	3	17	15	17	7	[illegible]	0	0	0.2	5	....	....	5
March	17.76	24.29	19.12	20.39	28.75	7.79	48.1	-22.4	37.2	6.1	15	19	4	8	3	14	7	16	7	2.5	0.04	1	0.8	15	....	....	7
April	34.12	38.76	33.88	35.59	41.04	24.40	66.1	8.9	42.7	6.6	20	30	0	1	3	4	4	13	10	2.6	1.22	6	0.1	2	2	....	3
May	46.90	50.10	44.97	47.32	52.38	36.01	76.5	19.1	29.3	7.6	8	21	5	1	6	16	10	21	5	[illegible]	1.95	11	0.8	4	....	....	4
June	56.55	59.69	54.88	57.04	63.54	43.20	92.1	26.9	34.3	6.3	27	28	1	2	3	13	0	13	[illegible]	3.0	1.64	9	8.	1	....	2	2
July	67.44	68.84	64.44	66.91	74.02	52.80	91.6	41.8	33.5	5.9	16	21	6	2	2	20	14	9	[illegible]	2.6	2.79	12	.....	....	1	1	1
August	62.59	65.84	60.54	62.99	68.52	51.74	81.3	34.9	30.6	7.0	19	14	0	2	1	23	16	12	[illegible]	2.1	6.11	17	.....	....	2	1	6
September	49.39	54.37	51.21	51.66	59.76	42.18	73.9	31.1	29.7	7.5	17	11	5	6	6	25	7	5	8	2.7	5.46	19	.....	....	1	1	6
October	39.00	43.99	39.83	40.94	48.64	33.08	66.8	7.6	27.1	7.1	7	2	5	5	16	27	10	7	14	[illegible]	1.74	14	3.0	5	....	....	7
November	18.38	28.75	25.65	26.48	30.40	19.45	40.8	4.3	23.0	7.9	9	5	1	0	8	14	12	20	12	[illegible]	R.	3	25.5	19	....	....	3
December	5.80	10.47	7.01	7.57	13.55	0.33	32.9	-18.4	20.9	7.8	2	3	0	2	1	20	22	33	10	2.7	R.	1	27.4	23	....	....	3
	33.49	38.81	34.47	35.76	.....	.....	92.1	-35.9	46.6	6.6	156	170	33	30	50	219	181	204	93	2.5	20.95	94	68.1	83	6	5	54

* During a part of the last two months of the year observations were made at 7 a.m., 2 and 9 p.m.

MOOSE FACTORY.

Abstract of Observations during the year 1879 *at Moose Factory, James' Bay. Latitude,* 51° 16′ *N.; Longitude,* 80° 56′ *W. By J. R. Nason, Esq.*

	TEMPERATURE.									Average amount of cloud.	NO. OF WINDS FROM									Average force of wind.	RAIN.		SNOW.		No. of fogs.	No. of thunder-storms.	No. of Auroras.
	7 a.m.	2 p.m.	9 p.m.	Mean.	Mean of highest.	Mean of lowest.	Absolutely highest.	Absolutely lowest.	Greatest range in 24 hours.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.		Amount of	Days of	Amount of	Days of			
	°	°	°	°	°	°	°	°	°												in.		in.				
January	-7.68	0.28	-4.15	-3.92	5.04	-14.38	24.0	-40.3	38.1	6.1	20	1	1	3	7	24	18	14	5	2.2	0	0	9.6	16	....	....	6
February	-12.70	0.16	-7.17	-6.72	3.69	-17.43	19.1	-41.3	40.6	5.5	8	5	0	3	4	13	18	19	14	2.2	0	0	8.1	10	....	....	6
March	8.28	19.35	10.37	12.08	23.31	-2.78	46.3	-33.4	57.5	6.3	10	2	3	6	12	18	13	12	17	2.5	0.60	3	9.8	13	....	....	9
April	22.40	29.32	22.53	24.19	30.35	15.77	52.2	-7.0	38.3	6.9	17	16	0	1	4	5	2	39	6	2.7	1.00	5	15.8	12	1	1	4
May	39.06	45.01	37.87	39.95	49.61	29.70	73.3	22.5	40.5	6.7	24	22	3	1	4	13	7	15	4	2.7	2.08	7	2.0	5	2	0	3
June	48.28	56.86	47.91	50.24	57.81	38.80	81.7	27.3	44.3	6.8	18	22	5	7	1	18	3	14	7	2.8	3.47	16	5.0	8	5	2	2
July	59.84	65.81	57.69	60.26	70.56	48.92	84.8	35.7	35.0	5.6	13	15	4	5	12	20	9	7	8	2.2	5.42	18	.....	....	2	0	1
August	56.28	63.39	55.72	57.78	66.51	49.58	82.8	38.1	29.0	6.4	16	25	4	3	8	7	10	12	8	2.3	2.60	13	.....	....	4	3	7
September	45.98	53.82	48.00	48.95	56.48	41.94	70.1	27.6	24.2	7.3	8	7	2	7	13	19	19	11	4	2.6	4.20	17	.....	....	2	0	8
October	42.23	49.40	44.47	45.14	54.29	37.72	81.8	17.3	38.3	7.4	11	6	5	6	9	25	8	20	3	2.9	2.25	12	2.0	6	....	1	4
November	18.73	23.05	20.71	20.80	26.35	14.89	53.2	-8.0	22.1	8.8	6	3	2	13	13	19	21	19	4	2.9	0.86	4	17.5	14	1	....	0
December	-15.53	-6.89	-11.19	-11.20	-1.52	-21.55	35.8	-45.3	48.3	5.2	9	7	3	4	4	20	26	11	9	2.5	0.65	2	15.8	12	....	....	8
	25.43	33.29	26.90	28.13	......	......	84.8	-45.3	57.5	6.6	160	131	32	49	91	196	154	193	89	2.5	23.13	97	85.6	91	17	7	53

MOOSE FACTORY.

Abstract of Observations during the year 1880 *at Moose Factory, James' Bay. Latitude,* 51° 16′ *N.; Longitude,* 80° 56′ *W. By J. R. Nason, Esq.*

	TEMPERATURE.									Average amount of cloud.	NO. OF WINDS FROM									Average force of wind 0–10.	RAIN.		SNOW.		No. of fogs.	No. of thunder-storms.	No. of Auroras.
	7 a.m.	2 p.m.	9 p.m.	Mean.	Mean of highest.	Mean of lowest.	Absolutely highest.	Absolutely lowest.	Greatest range in 24 hours.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.		Amount of	Days of	Amount of	Days of			
	°	°	°	°	°	°	°	°	°												in.		in.				
January	0.50	8.06	2.24	3.26	16.60	-11.34	40.8	-30.4	45.8	5.8	3	0	5	5	22	21	16	16	5	2.9	0.35	2	45.0	13	....	....	6
February	-9.89	3.58	-3.26	-3.22	8.16	-16.40	34.0	-34.6	57.4	5.9	18	5	1	1	4	19	21	16	2	3.0	0.03	1	12.5	12	....	....	4
March..............	-5.70	10.36	1.15	1.74	15.31	-12.45	49.5	-39.5	44.9	4.4	13	9	4	3	12	14	9	12	17	2.1	0.00	0	12.5	8	1	....	14
April	20.43	28.18	20.98	22.67	30.70	11.45	51.0	-10.1	34.8	5.5	19	17	2	3	6	14	8	14	7	3.0	0.07	3	3.0	6	....	....	11
May	38.55	44.47	38.78	40.15	49.54	31.56	73.9	12.8	33.0	7.4	17	28	3	6	5	8	8	10	8	2.8	2.67	15	4.0	6	....	....	5
June...............	54.30	60.02	52.55	54.86	63.93	44.40	82.8	38.3	35.4	6.6	30	16	2	5	2	15	6	6	8	2.4	3.86	15	S.	1	....	....	2
July...............	57.23	63.94	57.24	58.91	67.52	49.52	87.5	40.3	25.3	6.2	16	26	1	3	0	12	14	14	7	2.5	2.33	15	....	....	1	2	4
August.............	52.96	69.58	53.31	55.04	63.76	46.61	77.6	36.7	27.9	6.2	21	14	2	6	5	16	6	11	10	2.3	3.84	20	....	....	....	1	5
September.........	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
October............	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
November.........	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
December	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

MOOSE FACTORY.

Mean Daily Temperature from Observations at 9 a.m., 2 and 9 p.m., 1878.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°	°	°	°	°	°	°
1......	4.30	0.07	8.37	35.13	57.60	73.30	79.47	71.60	46.30	68.40	29.17	26.12
2......	-11.10	15.65	25.17	27.10	60.20	49.50	60.47	67.90	52.60	55.03	22.97	28.35
3......	-4.20	27.67	12.10	24.10	53.33	41.20	76.83	64.47	56.07	47.40	19.30	19.50
4	-22.97	26.70	9.10	35.07	52.90	35.30	50.17	61.73	67.97	45.43	18.67	14.17
5......	-26.73	33.83	22.80	36.30	52.47	32.40	67.63	66.53	48.37	44.67	17.40	8.97
6......	-24.27	20.57	37.63	28.23	50.00	35.30	84.17	60.70	51.13	44.23	29.53	12.23
7	-22.60	36.77	37.33	29.37	50.40	53.70	83.50	63.17	65.50	46.30	32.30	-5.75
8......	3.00	3.87	23.07	32.87	43.23	60.20	54.30	72.23	52.57	43.67	30.73	10.32
9......	15.35	4.27	27.83	45.60	33.90	50.80	52.37	61.07	64.60	44.93	30.93	5.90
10......	9.15	-5.37	10.60	47.37	33.17	54.63	63.73	59.03	58.23	44.23	22.73	18.30
11.. ..	15.42	-1.40	17.35	49.87	31.43	59.07	72.93	54.87	45.67	46.00	30.70	21.10
12......	29.23	6.70	31.37	43.57	23.10	59.73	66.23	68.90	48.20	49.23	27.37	13.40
13......	13.88	6.53	32.07	23.70	30.57	58.80	64.93	60.50	50.17	48.17	21.97	9.55
14......	20.83	8.20	19.47	28.97	32.63	75.27	60.37	54.93	49.90	54.73	17.33	5.25
15......	-9.60	13.58	35.93	32.10	36.50	58.50	68.43	54.80	48.20	40.43	21.33	14.27
16......	-15.87	1.37	20.93	31.30	47.40	48.10	70.17	63.63	55.03	39.10	29.80	15.03
17......	-2.60	-2.60	6.27	30.53	38.20	57.73	70.70	58.83	56.93	45.87	32.97	10.15
18......	26.87	13.85	28.23	......	46.63	69.10	75.67	70.80	47.17	36.73	38.07	-7.95
19......	29.87	19.40	16.05	29.27	57.67	60.90	65.23	62.47	47.00	38.20	37.40	-1.67
20......	9.33	7.72	3.42	29.60	39.07	39.27	71.13	63.30	42.23	43.37	30.03	4.20
21......	18.93	-16.28	0.73	26.67	59.87	50.53	62.30	63.97	42.07	54.53	32.23	0.73
22......	-14.47	23.63	14.55	28.40	62.17	59.53	63.03	74.00	48.67	49.87	30.57	-6.92
23......	-21.97	15.12	-1.08	50.57	70.00	63.77	77.30	71.40	63.57	34.93	32.77	2.57
24......	-8.13	8.65	2.22	51.77	55.00	59.73	63.87	63.20	45.73	33.07	29.40	14.85
25......	-14.43	15.55	20.33	37.80	56.40	41.93	54.27	53.27	43.40	34.77	23.80	12.80
26......	-5.63	35.90	26.43	32.57	48.07	61.27	63.97	50.77	40.23	27.83	21.87	6.95
27......	-12.23	28.57	22.47	35.73	42.57	77.90	55.87	55.10	44.47	23.43	30.17	-4.25
28......	-11.53	-7.70	25.63	29.67	44.60	84.67	57.87	58.77	52.27	24.57	18.07	-11.50
29......	0.33	....	35.13	40.00	43.87	82.27	58.20	61.20	56.87	21.23	11.77	-3.32
30......	-3.53	....	34.13	61.77	60.67	88.10	71.63	74.90	57.63	22.53	12.07	1.30
31......	0.10	....	31.37	....	73.47	....	78.27	64.70	....	21.30	....	5.85

MOOSE FACTORY.

Mean Daily Temperature from Observations at 7 a.m., 2 and 9 p.m., 1879.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°	°	°	°	°	°	°
1......	-1.95	-1.53	-4.35	9.65	29.63	41.23	76.29	57.78	59.45	55.23	19.55	7.90
2......	0.78	6.50	7.10	1.03	28.52	44.07	70.62	64.25	57.08	61.47	14.48	-11.98
3	12.25	16.47	30 05	13.02	32.38	61.23	42.60	59.72	61.55	42.28	16.08	-11 37
4......	5.15	11.48	-9.50	12.68	32.97	47.65	45.30	62.56	50.60	36.70	15.92	-7.58
5......	-2.87	9.27	-10.67	17.40	36.03	37.37	61.40	56.20	48.02	40.80	21.78	18.32
6......	-7.08	3.65	14.70	26.97	33.40	38.05	69.12	49.00	50.88	68.42	32.77	33.23
7......	20.67	-1.35	10.13	14.63	42.77	35.98	72.62	53.63	45.70	73.83	36.85	6.92
8......	8.45	4.93	27.45	25.25	50.83	47.72	61.10	47.65	44.20	47.10	38.95	-10 58
9......	-5.42	-15.52	30.45	12.37	49.30	58.28	59.68	53.50	49.17	48.82	38.47	-1.55
10......	-8.35	12.00	35.52	10.48	37.10	61.23	67 08	56.07	56.92	64.00	31.17	21.95
11......	-1.55	-8.96	12.08	10.92	57.90	53.40	58.65	57.73	60.28	52.90	31.65	-13.67
12......	-4.10	-10.75	8.90	11.75	34.80	42.17	58.12	52.22	58.30	49.80	30.87	-23.40
13......	-16.13	-21.95	9.30	22.05	30.20	47.43	50.45	50.20	39.80	46.20	34.25	-13.55
14......	-22.15	-21.42	4.00	29.43	34.60	34.20	61.60	44.68	39.77	61.08	33.98	-6.50
15......	-14.15	-11.90	-6.23	29.85	53.07	35.85	67.85	51.62	51.53	55.85	31.00	-15.10
16......	5.85	-22.33	-5.95	31.22	45.65	42.77	55.85	55.53	51.70	60.85	24.55	-15.48
17......	17.50	-16.60	-0.75	27.48	30.35	50.75	53.28	52.50	44.80	65.77	21.65	-13.00
18......	-5.45	-12.77	4.17	25.30	33.35	53.60	57.97	60.50	43.25	34.60	17.87	-34.50
19......	-19.10	-8.48	6.03	30.70	45.73	70.75	67.55	64.87	40.65	33.33	20.08	-18.47
20......	-18.65	-30.56	9.82	28.80	36.70	68.17	59.10	63.13	40.82	47.12	-9.75	-33.30
21......	-28.17	-10.30	7.55	31.60	29.05	64.67	62.20	67.50	47.88	37.73	4.75	-36.90
22......	-27.10	9.75	19.15	39.95	31.92	45.67	55.88	62.65	43.20	37.45	19.62	-10.65
23......	5.00	-3.50	22.93	29.95	59.95	53.08	48.75	54.97	35.40	26.85	5.49	-13.60
24......	-14.05	-8.60	4.90	40.70	43.33	44.40	57.32	55.13	35.93	21.52	17.05	-32.08
25......	-22.50	7.37	10.47	37.20	34.02	50.15	64.55	57.47	42.20	35.20	11.55	-28.23
26......	-9.03	-24.97	24.38	33.57	48.13	55.57	60.18	60.70	46.43	40.38	7.63	-28.10
27......	12.42	-15.98	37.20	44.20	42.80	59.17	59.10	65.85	47.75	39.80	17.35	-11.50
28......	-4.60	-9.82	39.52	26.55	41.05	55.82	54.92	61.58	59.45	34.47	11.75	-22.65
29......	8.10	....	14.03	25.80	51.80	46.13	50.93	56.65	60.80	35.28	7.00	-24.65
30......	7.95	....	8.22	27.75	47.52	59.17	66.87	65.67	58.50	28.65	10.80	-27.05
31......	7.45	....	14.80	....	36.18	....	66.00	70.83	....	23.00	....	4.57

MOOSE FACTORY.

Mean Daily Temperature from Observations at 7 a.m., 2 and 9 p.m., 1880.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°	°	°	°	°	°	°
1......	17.30	-20.93	-6.90	36.73	32.00	39.08	60.45	56.25	......	......	......	......
2......	-6.00	-8.90	-1.13	33.62	30.47	39.25	68.25	53.63	......	......	......	......
3......	5.87	....	14.33	29.40	24.03	52.27	73.90	58.57	......	......	......	......
4......	9.60	-16.13	-6.62	24.00	22.37	61.07	57.70	50.20	......	......	......	......
5	5.52	-11.27	-11.25	11.57	29.57	61.13	64.67	52.40	......	......	......	......
6	12.77	-18.85	-1.55	9.40	26.55	42.47	53.12	47.90	......	......	......	......
7......	0.70	-12.97	-13.80	16.35	34.90	40.00	53.37	56.75	......	......	......	......
8......	16.95	-19.57	-21 30	15.63	46.38	48.02	63.25	60.70	......	......	......	......
9......	21.20	-16.67	-12.27	28.85	44.35	57.20	50.23	54.88	......	......	......	......
10......	-6.05	6.90	-19.83	12.63	45.07	51.83	48.67	55.25	......	......	......	......
11......	9.50	7.15	-18.75	8.62	39.22	42.17	54.50	61.82	......	......	......	......
12	-16.27	13.05	-12 05	9.13	33.37	38.00	55.25	64.08	......	......	......	......
13	-15.88	-8.65	0.70	3.73	33.07	46.85	49.53	51.95	......	......	......	......
14......	11.55	-2.73	5.57	8.32	47.43	53.95	58.37	46.90	......	......	......	......
15......	2.63	8.85	9.92	18.42	47.13	58.20	60.90	52.70	......	......	......	......
16	8.80	-6.23	2.03	21.57	39.95	60.83	58.57	55.03	......	......	......	......
17	10.50	26.80	2.70	28.63	32.48	73.03	52.20	66.60	......	......	......	......
18	14.45	-0.68	8.18	43.97	41.75	59.63	52.92	65.60	......	......	......	......
19	-10.45	-4.67	21.30	42.40	50.30	66.37	53.27	48.92	......	......	......	......
20	-17.40	10.77	-6.80	23.45	26.83	49.18	52.57	49.72	......	......	......	......
21	7.25	6.80	18.87	23.37	39.02	51.10	59.93	53.45	......	......	......	......
22......	6.17	8.80	2.35	23.22	47.05	56.78	56.52	57.75	......	......	......	......
23......	-4.50	-22.80	-6.67	29.45	46.08	67.33	62.42	57.25	......	......	......	......
24	2.10	19.62	-8.80	28.25	57.60	68.60	67.40	47.60	......	......	......	......
25......	15.50	0.50	2.42	33.60	55.53	58.22	58.67	45.78	......	......	......	......
26......	29.40	-4.77	25.47	19.75	38.70	55.07	53.48	55.20	......	......	......	......
27......	8.57	-9.73	12.97	23.67	38.70	69.30	51.27	58.80	......	......	......	......
28......	-13.97	-6.83	13.70	30.17	37.25	58.43	53.28	52.57	......	......	......	......
29......	-13.98	-6.93	8.82	25.20	55.75	55.17	66.90	48.93	......	......	......	......
30.....	7.50	....	14.85	21.13	53.83	65.13	76.75	54.40	......	......	......	......
31......	-16.17	....	38.43	....	48.37	....	77.95	64.65	......	......	......	......

MOOSE FACTORY.

Highest and Lowest Temperature for each Day during the Year 1878.

	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°		°	°
1	21.2	-4.3	7.9	-13.1	14.8	-22.4	37.3	15.2	62.9	46.1	78.1	59.0	91.0	73.9	78.3	63.9	51.1	45.8	66.6	57.3	35.2	15.1	32.9	12.7
2	-5.4	-16.7	23.0	-14.5	30.6	13.9	35.3	15.6	65.0	40.9	72.7	47.0	74.0	57.0	71.2	58.8	58.6	45.5	66.8	47.0	27.8	17.0	30.3	24.5
3	5.5	-18.8	31.4	17.3	24.0	10.3	31.3	17.9	58.0	42.1	49.0	38.7	80.5	47.0	73.2	56.8	60.8	41.3	50.7	41.1	25.9	11.3	28.9	16.3
4	21.0	-25.6	34.4	13.5	14.8	-9.2	38.8	16.8	61.1	43.0	59.5	33.6	80.2	47.0	68.0	55.9	73.9	46.1	50.3	38.2	23.0	11.7	19.6	10.8
5	-17.7	-35.9	37.1	27.1	28.0	12.0	42.0	8.9	51.9	37.6	35.3	28.9	72.7	42.4	71.4	55.2	68.4	45.8	61.2	34.1	25.0	11.3	12.1	4.2
6	-16.5	-30.5	32.6	16.3	43.0	20.6	34.3	18.7	28.0	37.5	38.5	26.9	89.5	60.7	70.1	54.2	55.2	43.2	48.9	30.5	-32.0	12.9	15.2	8.9
7	-15.1	-31.9	39.1	20.2	48.1	29.9	33.7	26.0	56.0	44.8	57.3	31.1	91.6	60.6	68.8	52.8	70.7	51.9	60.3	36.4	36.3	24.3	11.1	-11.2
8	12.6	-20.2	36.4	-7.4	32.7	19.7	36.4	23.0	49.5	33.8	57.4	37.9	88.1	51.9	76.2	52.7	66.4	50.7	48.1	39.3	35.0	23.1	15.9	-14.0
9	18.2	6.9	3.0	-21.7	34.9	19.7	49.7	10.9	58.3	31.2	54.1	37.3	60.1	41.0	......	......	71.3	46.2	47.3	39.3	35.0	25.5	12.4	0.4
10	21.5	7.6	2.6	-18.2	23.4	7.1	52.6	28.4	35.9	30.0	59.3	40.1	67.2	44.8	62.0	53.7	71.1	56.2	60.5	40.6	33.8	27.7	17.6	-1.9
11	19.1	4.6	8.3	-15.5	22.6	-1.3	54.9	38.0	34.8	28.0	62.1	39.3	78.0	48.0	58.8	50.4	57.9	40.1	46.6	36.1	32.9	29.0	22.6	16.8
12	31.5	16.0	10.9	-1.9	35.7	15.9	53.6	38.0	28.5	20.6	63.7	41.0	81.9	56.0	74.2	44.6	55.1	36.9	55.7	34.7	31.8	23.3	21.2	10.8
13	31.4	10.5	10.1	4.0	34.8	29.7	38.9	34.0	32.7	19.1	63.5	39.6	69.8	48.0	60.8	56.0	53.1	37.4	51.9	37.3	23.8	10.0	12.3	5.4
14	22.9	8.4	14.3	-11.3	29.8	13.3	32.3	22.0	37.2	19.9	78.6	46.8	65.1	53.1	59.4	51.3	54.1	45.1	59.9	42.5	21.1	14.3	8.3	-1.0
15	20.4	-13.0	23.8	2.0	44.4	9.9	36.0	20.1	39.2	28.7	78.2	44.0	71.0	52.7	59.2	50.5	51.8	40.1	57.6	37.3	27.0	4.3	20.6	5.7
16	-5.6	-26.8	12.5	-2.0	38.4	11.4	34.6	24.7	54.5	70.4	49.9	42.9	72.8	59.8	60.1	47.9	57.8	50.8	40.7	31.5	32.0	16.7	16.3	12.7

17	8.9	-21.5	5.5	-19.9	12.2	0.9	34.2	26.0	43.3	34.7	63.3	42.1	74.3	63.7	64.8	54.7	62.5	47.4	58.7	37.8	38.4	24.6	15.1	6.7
18	31.5	-6.2	18.2	-18.8	34.0	0.2	37.4	25.8	46.1	30.9	65.1	42.2	85.1	65.0	73.7	53.0	53.4	37.4	45.9	33.8	40.8	27.8	10.0	-12.1
19	32.7	25.0	27.5	7.5	31.4	11.8	33.1	27.6	63.9	34.9	72.2	51.0	69.1	56.0	67.0	55.8	61.4	36.7	58.4	26.9	40.5	33.8	1.5	-13.8
20	25.4	7.7	17.2	3.8	13.0	-0.2	32.2	24.0	51.0	34.0	55.0	36.1	79.7	62.0	66.3	51.2	49.2	37.3	50.3	30.3	34.0	24.1	9.0	-4.5
21	21.8	7.6	22.4	0.3	16.2	-18.6	31.6	18.8	46.2	26.0	54.4	34.9	68.0	53.4	66.7	48.1	60.6	33.5	63.6	38.2	33.8	28.5	10.9	-4.8
22	20.4	-21.7	28.0	19.8	24.2	0.9	32.3	24.9	68.2	32.9	63.5	37.7	67.2	49.7	79.6	49.0	58.7	33.1	57.6	41.9	33.0	28.1	-3.2	-9.4
23	-12.8	-31.4	23.3	14.0	9.0	-6.0	57.5	16.8	73.7	44.4	68.3	48.9	79.0	45.3	75.2	63.1	69.3	45.4	42.3	32.8	33.9	30.3	4.8	-8.6
24	-0.9	-25.3	14.7	4.9	11.1	-18.7	57.6	23.1	66.0	50.7	59.7	43.9	70.7	59.4	70.8	56.2	65.8	36.1	55.9	29.8	33.0	28.3	18.3	4.2
25	-5.1	-25.9	26.0	-10.0	23.0	2.6	50.5	43.5	59.6	52.1	45.5	33.8	59.2	41.8	59.2	43.6	45.9	41.1	37.5	28.5	28.4	17.7	16.9	10.8
26	3.1	-17.7	42.5	18.5	33.7	17.8	34.7	31.0	55.5	46.0	69.1	34.8	69.5	42.7	55.2	38.2	46.0	39.1	30.1	26.5	25.9	7.4	19.6	0.5
27	9.1	-14.3	37.1	18.0	27.0	18.9	45.0	28.1	46.1	34.7	81.8	55.8	60.1	44.2	61.5	39.5	52.1	31.1	27.0	19.3	33.0	24.5	2.4	-8.9
28	-3.9	-21.8	18.6	-10.0	31.5	3.1	32.1	28.7	47.4	35.4	88.9	63.1	66.6	44.8	62.6	34.9	63.3	44.3	27.2	12.2	30.0	7.4	-2.5	-18.4
29	5.7	-7.3	......	.....	42.0	10.2	45.2	27.9	47.7	35.7	90.0	69.7	61.3	47.3	67.3	50.7	64.7	42.5	27.9	18.3	15.9	7.4	2.0	-17.6
30	7.8	-19.3	......	......	41.6	21.9	66.1	23.4	66.1	40.9	92.1	67.9	74.7	56.1	81.3	58.7	62.7	47.4	27.2	7.6	13.7	8.2	7.3	-2.8
31	12.3	-15.5	......	......	37.2	15.2	......	......	76.5	49.4	.....	......	81.6	61.7	74.8	51.0	......	......	25.2	18.3	.....	......	11.1	-12.2

MOOSE FACTORY.

Highest and Lowest Temperature for each Day during the Year 1879.

	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1	10.9	-7.0	4.2	-18.0	8.9	-13.7	15.1	6.9	33.7	26.7	45.9	27.3	83.3	60.2	61.5	51.5	64.8	57.1	66.5	51.3	22.2	18.1	25.2	3.7
2	3.2	-8.9	8.1	0.1	21.6	-19.2	7.2	-7.0	30.6	24.3	64.2	34.5	81.8	65.2	77.8	55.0	62.6	53.1	71.8	51.0	18.5	12.5	4.0	-15.9
3	17.5	2.9	18.9	7.2	41.8	-8.2	14.8	5.2	37.1	24.6	75.9	31.6	65.3	38.4	71.6	53.0	68.2	52.1	58.8	40.8	22.1	11.8	-2.7	-27.7
4	18.6	1.1	17.9	6.2	37.5	-20.1	16.4	8.3	37.4	30.1	74.8	34.1	53.7	35.7	72.3	53.1	61.6	47.7	42.2	33.5	18.1	14.5	-1.2	-15.1
5	3.2	-6.0	18.4	4.3	-3.4	-33.4	23.8	9.2	44.9	25.4	43.4	31.8	68.9	37.1	67.3	49.3	55.6	45.4	48.9	34.4	26.6	15.0	25.4	-8.0
6	2.5	-23 0	11.1	-8.7	22.0	-4.1	40.4	13.5	42.2	29.1	41.7	30.9	82.7	52.9	58.9	44.5	54.8	42.0	77.0	38.7	31.0	21.4	35.8	24.8
7	24.0	2.0	12.0	-7.5	17.0	7.6	23.0	12.1	55.0	22.5	39.4	34.3	79.0	64.5	56.8	44.5	52.9	42.5	81.8	64.5	40.5	30.2	32.0	0.6
8	20.1	3.1	10.9	1.1	34.1	9.6	44.0	5.7	62.2	31.3	53.1	29.4	70.8	55.8	55.2	45.0	48.5	41.3	73.3	41.6	43.2	32.9	2.3	-18.0
9	2.9	-9 0	1.6	-20.3	35 4	17.3	19.2	8.6	59.6	38.2	66.6	45.3	68.9	50.2	53.7	46.0	59.5	33.8	49.1	42.5	53.2	32.3	4.5	-18.1
10	3.5	-16.8	19.1	-20.7	40.4	32.1	17.5	-0.6	45.7	32.8	68.2	54.3	80.3	55.8	66.0	44.1	67.0	43.3	73.3	49.0	33.0	30.8	30.0	3.4
11	2.7	-18.5	16.1	-16.6	32.0	10.6	19.4	-0.9	69.8	39.7	63.8	48.1	84.8	49.8	66.7	44.1	70.1	45.9	63.8	43.8	33.0	30.4	26.2	-22.1
12	2.3	-11.5	-7.1	-17.4	17.6	4.5	20.4	-1.8	54.7	31.4	50.2	38.0	68.8	40.0	58.8	47.5	65.9	52.6	56.8	45.0	32.2	29.3	-17.7	-34.8
13	-3.0	-25.5	-11.3	-30.0	14.4	-12.1	20.0	2.3	35.0	27.2	64.4	31.6	62.9	45.7	56.8	46.9	57.2	36.3	50.9	32.1	37.0	27.5	-6.3	-29.2
14	-20.1	-37.8	-10.5	-38.3	22.8	-6.0	34.0	22.3	41.1	25.9	89.8	31.1	67.7	44.0	52.2	41.3	48.2	35.1	72.2	45.3	37.4	32.8	0.9	-18.0
15	-8.8	-24.3	1.8	-25.4	2.0	-19.9	37.4	26.3	63.0	26.4	40.2	28.6	78.8	58.0	61.2	38.1	58.7	34.8	70.6	45.3	33.8	28.1	-5.2	-20.1
16	10.4	13.0	-0.3	-26 3	3.3	-23.9	36.8	28.3	78.8	33.3	50.9	32.9	63.6	52.7	74.7	45.7	58.1	49.2	65.8	44.2	81.0	22.0	-8.6	-29.7

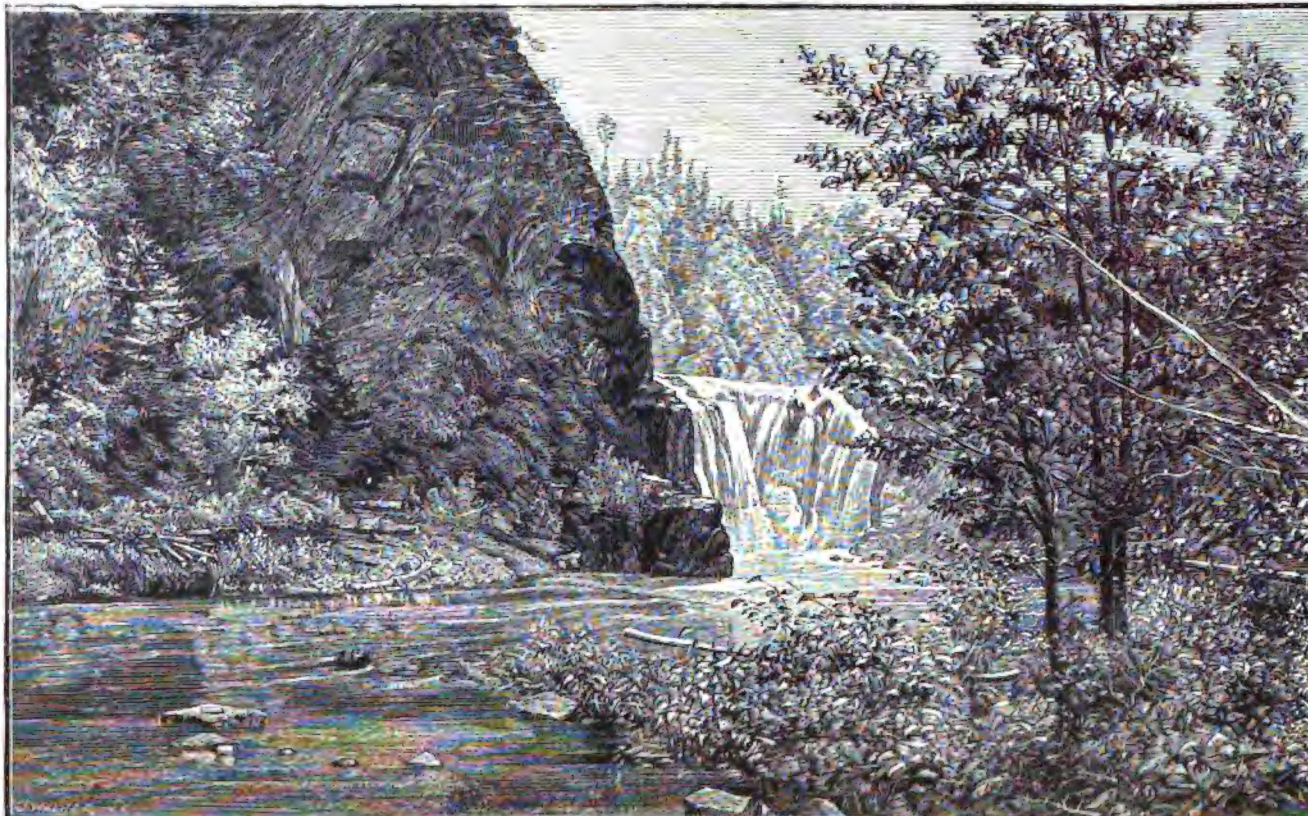
17	25.1	12.0	-0.8	-33.3	10.5	-15.9	35.5	25.3	33.8	27.3	57.6	38.4	61.1	46.4	56.8	46.2	51.9	40.5	71.9	61.3	26.1	18.8	-13.0	-26.4
18	13.1	-11.3	-4.6	-30.5	15.1	-12.7	29.9	22.4	37.3	25.4	63.6	44.6	70.8	44.1	69.0	47.2	46.6	37.5	64.8	30.8	20.3	16.8	-15.2	-29.2
19	-10.5	-30.8	12.3	-18.2	15.6	0.1	40.0	14.8	54.2	29.3	81.7	50.2	76.0	50.9	77.9	51.6	45.9	37.8	43.7	30.3	22.9	14.8	-7.3	-32.2
20	-8.1	-24.4	-17.9	-35.3	15.0	-17.8	44.1	12.7	47.0	29.1	78.8	61.2	70.2	53.0	71.0	54.1	46.2	33.7	56.7	30.2	16.6	-3.7	-18.1	-37.3
21	-20.2	-40.3	-0.7	-41.3	14.5	-6.0	37.0	24.6	36.1	24.1	75.4	59.0	69.6	50.2	76.3	60.3	55.6	33.5	52.9	35.7	9.1	-7.9	-20.0	-42.3
22	-15.1	-40.3	15.1	-1.6	29.0	-14.5	52.2	29.8	36.0	27.1	58.8	42.1	70.6	49.3	72.7	54.2	50.1	37.3	48.1	32.8	24.6	8.4	-7.1	-20.9
23	13.1	-25.0	9.9	-7.8	30.9	13.0	37.0	27.1	70.0	29.5	64.1	39.3	54.9	43.5	58.9	52.1	45.2	29.5	33.2	23.3	17.0	-1.1	-6.3	-19.2
24	12.0	-25.0	0.3	-13.2	23.8	-3.0	44.1	28.2	60.8	33.3	56.0	39.1	70.0	35.7	63.1	50.0	45.1	27.8	27.2	18.3	24.1	-2.5	-11.6	-30.2
25	-11.5	-30.5	2.6	-16.9	18.8	-17.3	48.0	33.3	46.0	28.4	53.9	39.2	71.9	48.1	65.8	48.8	45.8	27.6	40.0	17.3	27.0	-4.9	-22.0	-41.3
26	-1.7	-32.8	-10.3	-27.2	36.0	0.1	35.9	30.0	56.1	26.3	62.8	48.3	66.2	58.5	69.3	44.1	52.7	40.1	41.9	39.0	13.1	-8.0	-19.5	-26.2
27	15.8	-1.8	-9.3	-31.2	41.7	24.4	49.0	31.3	60.6	34.0	70.7	52.0	74.2	50.1	73.9	55.3	55.9	44.3	42.0	37.6	22.5	8.2	-2.3	-26.2
28	13.9	-10.0	2.3	-21.2	46.8	34.3	38.3	23.5	48.0	27.3	66.6	49.8	57.3	49.0	68.1	57.8	64.6	43.5	58.3	31.1	17.6	4.7	-14.8	-28.8
29	19.4	-13.8	......	......	37.0	10.2	31.3	23.2	55.4	37.3	55.8	41.6	65.6	50.2	60.7	53.3	66.8	57.8	38.2	32.3	13.1	4.1	-16.8	-31.2
30	11.9	5.0	......	......	15.8	1.9	30.0	24.3	70.9	39.3	63.8	34.3	72.9	43.4	74.0	52.3	56.8	55.0	35.2	25.8	17.1	0.1	-21.0	-45.3
31	9.1	-9.7	......	......	25.1	-2.3	......	......	40.3	34.0	......	......	74.7	58.2	82.8	60.1	.....	......	26.1	21.3	......	......	8.4	-16.9

MOOSE FACTORY.

Highest and Lowest Temperature for each day during the year 1880.

	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1	29.5	-7.2	-12.7	-30.7	2.3	-23.3	44.0	28.8	45.8	12.8	44.2	34.3	68.8	52.2	77.6	50.3	......	......	......	......	......	......	......	......
2	32.0	-16.9	2.0	-24.1	14.2	-10.5	44.0	29.3	37.7	23.4	46.2	33.3	80.3	50.6	60.2	47.0	......	......	......	......	......	......	......	......
3	16.9	-26.0	-3.6	-24.1	26.0	6.0	22.2	24.3	32.2	18.3	62.3	33.7	80.8	58.1	68.0	44.0	......	......	......	......	......	......	......	......
4	30.5	-1.4	-4.6	-29.0	8.0	-13.0	32.0	18.8	25.1	18.1	67.0	46.3	70.9	51.5	54.9	47.0	......	......	......	......	......	......	......	......
5	15.1	-16.1	4.2	-20.6	3.0	-20.1	21.4	6.7	31.8	24.3	70.1	54.3	76.7	53.0	66.9	45.4	......	......	......	......	......	......	......	......
6	35.1	-2.9	-7.4	-31.1	9.3	-20.1	18.1	-0.1	32.0	15.5	60.3	38.3	61.0	42.2	54.0	42.3	......	......	......	......	......	......	......	......
7	6.2	-9.0	-1.7	-25.9	5.9	-24.1	24.4	-3.7	42.5	18.5	43.9	37.5	55.0	47.4	63.8	42.8	......	......	......	......	......	......	......	......
8	23.5	-4.1	-5.5	-27.7	-4.0	-38.4	23.9	-1.7	57.2	33.6	55.4	37.3	69.9	46.2	72.7	53.5	......	......	......	......	......	......	......	......
9	40.8	2.6	-10.6	-34.6	-4.6	-22.5	42.0	21.2	50.8	37.5	61.6	41.5	59.6	45.8	64.3	51.2	......	......	......	......	......	......	......	......
10	-2.3	-14.7	14.4	11.0	-6.5	-31.8	25.1	8.2	52.9	39.6	62.3	47.3	58.5	43.2	64.2	42.5	......	......	......	......	......	......	......	......
11	25.1	-2.9	13.1	-5.6	0.8	-39.5	15.1	3.3	48.9	34.5	47.0	39.5	61.8	40.3	71.9	48.2	......	......	......	......	......	......	......	......
12	-3.4	-20.8	22.1	5.6	1.5	-26.2	14.6	-4.6	37.3	30.8	43.2	34.3	61.7	50.0	76.7	54.4	......	......	......	......	......	......	......	......
13	-7.7	-29.2	5.4	-16.1	12.2	-24.5	11.1	-2.0	38.9	27.8	53.8	33.9	59.3	43.0	58.7	48.8	......	......	......	......	......	......	......	......
14	30.2	-15.6	6.0	-27.2	10.8	2.1	15.0	-10.1	54.9	24.5	61.6	37.0	65.3	42.3	51.1	44.8	......	......	......	......	......	......	......	......
15	10.1	-12.0	18.1	1.6	19.1	-7.3	25.9	11.2	65.8	33.8	66.8	42.5	70.7	50.4	59.8	42.5	......	......	......	......	......	......	......	......
16	16.1	-2.1	6.2	-12.3	17.4	-7.8	32.3	-2.5	49.0	35.5	67.2	44.3	67.8	51.8	72.0	50.1	......	......	......	......	......	......	......	......

17	26.3	-0.9	34.0	-11.0	17.1	-20.8	37.2	15.4	44.0	28.5	82.8	47.4	57.8	48.5	73.7	49.5	.....	.....	.....	.....	.....	.....	.....	.....
18	27.5	-10.2	34.0	-5.5	33.7	0.0	51.0	29.3	46.2	26.6	72.0	56.2	58.6	49.0	74.9	49.4	.....	.....	.....	.....	.....	.....	.....	.....
19	19.1	-17.1	-1.6	-10.0	33.8	-9.2	50.0	36.7	65.9	42.8	82.3	52.3	61.8	49.4	61.9	46.4	.....	.....	.....	.....	.....	.....	.....	.....
20	-6.6	-28.7	18.9	-14.0	26.8	-12.0	42.5	15.3	42.0	25.3	60.3	42.5	56.7	42.3	52.5	43.0	.....	.....	.....	.....	.....	.....	.....	.....
21	5.8	-25.2	20.1	2.1	22.1	-22.8	32.7	15.6	45.0	24.8	58.8	37.4	69.0	50.5	57.7	51.2	.....	.....	.....	.....	.....	.....	.....	.....
22	11.4	-3.4	21.5	-4.2	20.0	-4.1	29.0	8.2	51.8	38.3	65.2	42.7	60.8	52.2	63.4	49.0	.....	.....	.....	.....	.....	.....	.....	.....
23	6.5	-9.2	7.9	-27.6	2.3	-11.0	37.0	12.6	53.4	40.4	78.7	54.1	71.4	50.1	64.6	52.4	.....	.....	.....	.....	.....	.....	.....	.....
24	12.1	-20.8	32.0	-25.4	0.8	-22.7	33.8	14.8	64.0	41.3	76.6	60.3	78.9	54.6	56.1	44.8	.....	.....	.....	.....	.....	.....	.....	.....
25	20.3	11.8	23.0	-5.2	28.9	-13.6	46.0	14.3	62.7	52.6	78.8	46.3	74.9	49.6	52.9	36.9	.....	.....	.....	.....	.....	.....	.....	.....
26	36.0	7.6	1.9	-11.9	39.0	4.2	33.2	12.3	53.9	34.8	61.8	41.4	61.5	49.0	6[illegible].8	39.0	.....	.....	.....	.....	.....	.....	.....	.....
27	36.8	2.6	-2.4	-13.5	27.0	7.9	35.0	12.5	53.5	33.6	78.1	58.0	60.6	46.3	61.8	51.1	.....	.....	.....	.....	.....	.....	.....	.....
28	2.3	-18.1	-1.6	-16.1	21.1	2.1	38.4	13.8	45.7	29.8	72.9	53.9	63.4	42.3	64.0	49.2	.....	.....	.....	.....	.....	.....	.....	.....
29	-7.3	-30.4	-1.6	-10.5	19.0	0.0	35.8	14.3	64.6	34.0	62.8	47.5	76.9	45.3	53.6	43.4	.....	.....	.....	.....	.....	.....	.....	.....
30	13.3	-9.7	....	......	34.0	7.6	29.0	12.5	73.9	50.0	73.8	46.1	87.5	64.0	62.8	36.7	.....	.....	.....	.....	.....	.....	.....	.....
31	7.4	-22.1	......	.....	49.5	9.3	......	......	66.3	41.7	......	......	85.1	68.1	76.1	48.2	.....	.....	.....	.....	.....	.....	.....	.....



Geological Survey, 1880.

TÊTE À GAUCHE FALLS, N.B.

From Photo. by R. W. Ells

GEOLOGICAL SURVEY OF CANADA.

ALFRED R. C. SELWYN, LL.D., F.R.S., F.G.S., DIRECTOR.

REPORT

ON THE GEOLOGY OF

NORTHERN NEW BRUNSWICK,

EMBRACING PORTIONS OF THE COUNTIES OF

Restigouche, Gloucester, and Northumberland,

1881.

BY

R. W. ELLS, M.A.

PUBLISHED BY AUTHORITY OF PARLIAMENT

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DAWSON BROTHERS.
1881

ALFRED R. C. SELWYN, ESQ., LL.D., F.R.S., &c.,

Director of the Geological Survey of Canada.

SIR,—The present Report, comprising the result of the explorations of the past two seasons in northern New Brunswick, is herewith submitted. The map to accompany it has been prepared on the scale of four miles to one inch, in conformity with those lately published of the southern part of the Province, but from the lack of some topographical details which will necessitate a few weeks' further survey to render complete, it has been deemed best to withhold its publication till next year.

During the season of 1879 I was assisted by Mr. Frank D. Adams, B. Ap. Sc., now permanently attached to the staff of the Survey, and by Mr. Thomas D. Peers, of Halifax. N.S., and in 1880 by the latter of these gentlemen. Our thanks are due especially to Messrs. W. J. O'Brien of the Customs Department and Savings Bank, Bathurst, for many kind attentions, to Messrs. Burns, Adams & Co., of the same place, who kindly furnished us with the means for towing our supplies up the Nipisiguit River, and also supplied us with provisions from their depots in the interior, and to Mr. Joseph Hickson, Fishery Inspector for the County of Gloucester. Also to Mr. Reid, of the Clifton Grindstone Quarries, and to the Crown Lands Department for copies of surveys of rivers and other information. The work of the Survey during the season of 1879 consisted principally of the exploration of the Rivers Nipisiguit, Upsalquitch, Restigouche, Tobique and its right hand branch, and the Tête à Gauche, embracing a canoe journey of some 650 miles; surveys of the coast from Bathurst north to Campbellton, and of the roads in the counties of Restigouche and northern Gloucester, as well as examinations of the Devonian rocks in the vicinity of Dalhousie before undetermined. In 1880 the work embraced the Jacquet River and the Quebec shore from the Metapedia to the mouth of the Neuvelle River opposite Dalhousie, the explorations of the North-west Miramichi and its branches, the Sevogle and Little South West to their sources, the main South-west Miramichi, the south branch of the Nipisiguit, and the wilderness country lying around the heads of these streams, and road surveys in southern and eastern Gloucester. In the greater part of the area embraced in these explorations, the work was necessarily performed by canoe; good chain surveys of the principal rivers being often obtained from the Crown Lands Department of the Province, by means of which our work was greatly facilitated. The

Assistants.

Obligations.

Area examined

General character of country in the interior.

entirely unsettled state of the country inland, and its dense forest growth, often blown down and forming an impenetrable jungle, rendered the work very difficult, and the tracing of geological boundaries, with accuracy, in many places an utter impossibility. During the two seasons nearly 2000 miles of exploration in canoes and nearly 1000 miles of road and other surveys were accomplished; and, considering the unsatisfactory character of the country, it is believed that the relations and boundaries of the different geological formations have been determined with a fair approach to accuracy. A series of photographic views was also obtained, illustrating points of interest along the principal rivers and the general character of the country and its scenery.

I have the honor to be,

Sir,

Your most obedient servant,

R. W. ELLS.

Geological Survey Office,
May, 1881.

REPORT

ON THE GEOLOGY OF

NORTHERN NEW BRUNSWICK,

EMBRACING PORTIONS OF THE COUNTIES OF

RESTIGOUCHE, GLOUCESTER, AND NORTHUMBERLAND,

BY

R. W. ELLS, M.A.

Previous to the commencement of the work in this portion of the Province, in 1879, the determination of the various geological formations was of a very general character, and their boundaries somewhat loosely defined. Explorations had been made to a limited extent along the coast by Sir W. E. Logan, in 1843, in connection with the so-called Bonaventure formation; by Dr. Abraham Gesner about the same date, the result of whose observations appeared in his report to the New Brunswick Government; by Prof. H. Y. Hind, in 1864, who made a traverse of the Tobique and Nipisiguit Rivers, as also of the main south-west Miramichi, by whom the great bulk of the metamorphic rocks, as seen in these streams, was assigned to the Quebec Group, and whose report to the New Brunswick Government (1865) contains a large amount of very valuable information. Brief papers also appeared in the *Canadian Naturalist* by Prof. L. W. Bailey, of Fredericton, who made a canoe voyage from the St. John River to Bathurst, by way of the Tobique and Nipisiguit Rivers, and in the *Transactions of the Nova Scotia Institute of Natural History*, by the Rev. Dr. Honeyman, more particularly with reference to the country about the upper part of the Bay Chaleur, and in the vicinity of Dalhousie. **Work previously done in this area.**

The working out of the stratigraphical relations of the different geological formations in the southern part of the Province has, however,

furnished us with a key by which we can more readily decipher the somewhat complex structure of the northern area, and in this respect the different divisions will be found to correspond with those given in the Geological Survey Report 1877-8, on southern New Brunswick.

Two large streams, the Nipisiguit and the Tobique, take their rise in close proximity to each other near the central point of the northern half of the Province. The former enters the Bay Chaleur at the town of Bathurst, the latter, the St. John, about twenty miles below the Grand Falls, or just above the town of Andover. Both are easily navigable for canoes, and thus form a favorite route for travellers and tourists, not only from the magnificent scenery along their course, but from the quantity and excellence of the fish, both salmon and trout, which are especially abundant in the Nipisiguit. On this river the salmon are at present able to ascend only to the Grand Falls, or twenty miles from its mouth, but if fishways were erected by which they might pass this barrier, the stream above is especially adapted for their introduction and increase. Above the Falls, however, trout of the finest quality, reaching as much as five pounds in weight, are found in the greatest abundance. About its head-waters, moose, cariboo and bears are numerous, whilst beavers are plentiful in most of the smaller tributaries. The surface of the country, especially along the upper part of the river, is exceedingly mountainous; ranges of hills from 1200 to 2000 feet in height, with scattered peaks of even greater elevation, affording a succession of magnificent views which can be surpassed in no other portion of the Province. The Nipisiguit receives a number of tributaries, but none of any considerable size with the exception of the Main South Branch which comes in at 60½ miles from its mouth. This stream rises about thirty miles to the south, and flows through an exceedingly rough and mountainous country. From the frequency of its falls and rapids its lower part, for about six miles, is difficult for canoes, but above this point no such obstacles exist.

General description of the Nipisiguit river.

From the head of Nipisiguit Lake a portage of about two and a-half miles extends to Nictor Lake or head of the Little Tobique or Nictor River. This lake is about four miles in extreme length, with an average width of about half a mile. A large mountain towers along its southern margin and thence stretches away to the south-west. From this lake the Little Tobique or Nictor flows for some thirty-five miles, mostly through a country very flat in the vicinity of the stream, the banks being from two to six feet above water and densely wooded with cedar, spruce, etc., till it meets the main branch or Campbell River and the Mamozekel. Thence the river becomes broad and flows through a magnificent farming country occupied by Silurian and Lower Carbon-

General description of the Tobique river.

iferous sediments, and now rapidly filling up with an industrious population. This stream contains abundance of salmon, which ascend the Right Hand Branch and the Serpentine, a branch of the last named stream. They do not, however, readily rise to the fly, but are taken in considerable quantities by spearing, despite the vigilance of the fish wardens. White fish (*Coregonus albus*) are also found in this river and can be taken by spearing.

Ascending the Nipisiguit, at sixty-two miles from its mouth, a small stream (Portage Brook) enters from the north, and affords a partial route to the Upsalquitch Lake, whence canoes can easily descend the Upsalquitch River to the Restigouche. The total length of the Portage between the Nipisiguit and the head of the lake is about seven miles, but in a good state of water this can be shortened by means of small brooks and beaver ponds to little more than one mile. On the Upsalquitch, after passing the lofty ranges of hills which characterise the country occupied by the felsitic and precambrian rocks hereafter described, the surface becomes less broken; the softer Silurian strata not affording such marked physical features. A second portage occurs on the river about eight miles below the lake, where a series of falls for a distance of over a mile render this portion of the river impracticable for canoes. The total descent on this stretch from the head of the portage to the mouth of Ramsay's Brook, two miles below, was found by aneroid to be about 130 feet. Below this the river is easily navigable for canoes, and much fine scenery is observed throughout its entire length. **Upsalquitch river.**

The Great Falls about six miles from the mouth of the river afford no obstructions to canoeing. Much apparently good land occurs along the lower part of this river, but the portion above the Forks is too rough and broken from the presence of hard felspathic and trappean rocks, to afford much valuable land for agricultural purposes. Examinations were made along the Restigouche in 1837, by Mr. Richardson of this Survey, as far up as the mouth of the Patapedia River, which for some miles forms the boundary between the Provinces of Quebec and New Brunswick. In continuation of this work our explorations were carried on to the point where the portage extends across to the St. John River.

The country along the upper part of the Restigouche is much less broken than about its lower portion; and much fine farming land will doubtless be found over the area occupied by Silurian rocks which here cover a large extent of country. At present, however, this region is inaccessible to the settler, and is available only as a source from which large quantities of spruce timber are derived. The route from the Restigouche to the St. John is up the Waagansis for about seven miles to the north end of the portage to Grand River. This *carry* is **Restigouche river.**

about three and a-half miles in length, whence by the Grand River the St. John is reached about fourteen miles above the Grand Falls.

The breadth of country in the Restigouche Valley occupied by rocks of Silurian age, from its southern margin on the Tobique to the Quebec boundary, across the strike of the beds, is about seventy miles. As much of the finest farming land of the Province is on rocks of this horizon, there will, doubtless, be found in this area, which comprises over 4000 square miles, a very large proportion of land suitable for settlement, which will be available as soon as means of access can be provided.

Settlement lands on the Restigouche.

The country in the vicinity of the Nipisiguit and Miramichi Rivers is of a totally different character. It is for the most part very rocky, the harder metamorphic rocks forming much more striking features. The soil is generally thin and often entirely denuded; so that except for timber a very large portion of the area between the Main South-west Miramichi and the Nipisiguit and the Tobique Rivers is worthless. The frequent fires also which have ravaged the country of the Miramichi River have destroyed large quantities of valuable timber, and for many hundreds of square miles the surface, especially in the vicinity of the head-waters of the North-west Miramichi and its branches, is completely wasted, nothing being left but the bare rock.

Character of the country on the Nipisiguit and Miramichi rivers.

In connection with the general progress of the work, explorations were made to some extent in the country to the south of the Tobique River, but as the time available for this area was limited, further examinations will be necessary before definite results can be obtained. During the entire exploration particular attention was paid to the discovery of minerals of economic value, and though traces of several were found, the quantities were so small and the conditions of their occurrence such, that in so far as yet seen but small inducement for the investment of capital in this direction is presented. Further reference will be made to this subject under the heading of Economic Minerals.

MIDDLE CARBONIFEROUS.

Area of the Carboniferous system of eastern New Brunswick.

The portion of the Province covered by rocks of this age is very considerable, and includes not far from a third of its superficial area. In its general outline it is roughly triangular, the apex being placed in the south-western portion of the Province at the Kedron Lakes on the boundary of Charlotte county. The length of the northern side of the triangle, from the apex to the Island of Miscou, is about 210 miles, its southern side to Cape Tormentine about 160 miles, and a direct line between the two eastern ends about 140 miles. Allowing for sea area under the Gulf of St. Lawrence, the number of square miles belonging

to this System will not fall far short of 10,000. It includes the greater part of the counties of Westmorland, Queens, Sunbury and Gloucester, a large portion of York and Northumberland, and the entire county of Kent in so far as known. Throughout the greater part of the country under discussion, the strata lie in a nearly horizontal attitude, rarely reaching an angle of 10°, but generally forming low undulations with angles of from 1°–4°. The surface of this large area is generally low and level or broken by ridges of moderate elevation. There is, however, a slight dip of the beds towards the waters of the Gulf of St. Lawrence, and from the general outline and structure of the formation, it would appear to have, at one time, formed a long sheltered and shallow bay, a western prolongation of the great Carboniferous basin which extended as far eastward as the Island of Cape Breton, and stretched from Gaspé on the north to the ridge of the Cobequids, in Nova Scotia, on the south. In the counties of Sunbury and Queens, the thickness of this formation has been determined by boring, but no efforts in this direction have yet been attempted in its eastern portion, and it is quite probable that it will be found to increase in thickness as we approach nearer the productive measures of Nova Scotia. Some color is lent to this supposition also from the non-occurrence of those ridges of older rocks (Lower Carboniferous and Devonian), which are found in the western portion about the head of the Grand Lake and on the Canaan River. The rocks resemble those already described in the Report of 1872-3 in the Grand Lake coalfield. Grey sandstone, shales and conglomerates predominate, but in the vicinity of the Gulf purple beds are seen like those exposed about the shore of Grand Lake, in Queens county. The boundary of the formation has been traced on its northern side from the Main South-west Miramichi near Boiestown, to the shore of the Bay of Chaleur, below Bathurst. The entirely unsettled state of a great part of the country, with its generally low and often swampy character, renders detailed observations very difficult. The Intercolonial railroad, however, affords a very fair section from Bathurst to Moncton, but the ordinary carriage roads disclose very rarely any rock exposures.

Probable greater thickness of the formation near the Gulf shore.

On the Intercolonial going south from Bathurst, exposures, though not very plentiful, are yet quite sufficient to determine the character of the formations. Leaving the Nipisiguit River where the red beds of the upper part of the Lower Carboniferous are seen resting on the granite we find, at the crossing of the Red Pine Brook, layers of reddish-purple sandstone and shale which probably are transition beds between the Lower Carboniferous and the Millstone Grit. Purple beds thence extend at intervals for several miles southward till we pass Red Pine station. These are presumably basal beds of the Millstone Grit

Bathurst to Newcastle.

as they are often found in this attitude in other parts of the Province. About midway between Red Pine and Bartibogue stations, grey sandstones, coarse and of the usual type of the Millstone Grit, come in for the first time in this direction, lying in a nearly horizontal position or with a slight northerly dip at angles of 1° to 3°. From this to Newcastle the same character is observed in all the cuttings. The sandstones are generally thin-bedded and unfitted for quarrying. Extensive peat bogs occur about the head-waters of the Tabusintac, but the surface is for the greater part sandy and covered with a sparse growth of scrubby spruce and pine.

Shore east of Bathurst.

Going eastward from Bathurst along the post road, which keeps near the shore the greater part of the distance, we find at Bass River, about four miles below the town, large blocks and probably ledges of grey grit of the usual coarse Millstone Grit type. These probably overlie directly the red beds which are exposed at the crossing of the Nipisiguit, and which constitute the upper portion of the Lower Carboniferous formation. As the country along the shore is generally low, exposures are limited, and, with one exception at Ellis' Brook, thirteen miles below Bathurst, where ledges of purple-red sandstone and shale are seen, the road shews no ledges in all the distance to Shippegan. The shore alongside, however, affords good sections for the greater part of the way from Salmon Beach eastward. The beds are all horizontal in attitude or in slight undulations as is the case over the central area. At Clifton, seventeen miles below Bathurst, there are large grindstone quarries extending for a stretch of two miles along the shore. The cliff here consists of grey sandstone and shale, and contains two seams of coal, the larger of which, according to Mr. Reid, the owner of the quarries, has a thickness of eighteen inches. This, however, includes much carbonaceous shale, the finer coal being only a few inches. The shales contain abundance of fine ferns of carboniferous type, and at several points portions of stems are seen standing upright in the face of the cliff. These exposures extend along the shore nearly to Blue Cove, about two miles below the point where the post road turns off to Caraquette, but disclose no beds of coal of any importance. At Caraquette, about half a mile below the church, a thin irregular seam is seen on the shore, of no value. Borings were made, some years ago, for the purpose of testing this place but without success. As we approach Shippegan the grey beds gradually sink and purple sandstones and shales come in. These in the Island of Shippegan are reported to contain a seam of coal several feet in thickness, but at the time of my visit, owing to wet weather and the unwillingness of the settlers to disclose its exact position, an examination of it could not be made. From Shippegan to Traçadie River the coast line is low, and consists of peat

Coal seam at Clifton. **Coal at Caraquette.** **Coal at Shippegan Island.**

bogs and sand bars; no exposures are seen, but the generally dark-reddish color of the soil would lead one to infer that the underlying rocks are purple sandstones and shales. The remainder of the coast from Tracadie to Bartibogue River has not yet been examined, but from the latter stream to Newcastle grey sandstones and grits form frequent exposures along the shore and continue westward up the Miramichi (N. W. branch) to the western limit of the carboniferous basin on the Little South-west Miramichi and Big Sevogle.

The shore on the south side of the Miramichi River and harbor to Point Escuminac is generally low, and consists in many places of sandy beaches and peat bogs. Low cliffs of grey and sometimes purple sandstone and shale occur at intervals, and ledges are seen on the shore below high water-mark, but the beds are so uniformly horizontal that surface examination alone affords but little information. Shore east of Chatham.

Over this country coal seams are reported at various points. Besides those already mentioned on the Bay Chaleur, thin seams are stated to occur on the Renous and Dungarvon, branches of the Main South-west Miramichi, and in the vicinity of the latter also at Doaktown. Coal is also said to occur on Barnaby River, about one and a-half miles from its mouth, and on the Napan, back of Chatham. Thin seams also are found on the shore at Black Brook, about six miles below Chatham. Many of these places have not yet been visited, but the reports all agree in saying that the outcrops are very thin and do not exceed a foot in thickness at any place. It would almost seem desirable that some effort to test the thickness of the formation in the vicinity of the Gulf should be made. Could workable beds be found at Shippegan their value would be very great; since from their nearness to the Montreal market a manifest advantage would be obtained over the mines of Pictou and Cape Breton. Coal seams of the Miramichi.

Lower Carboniferous—Bonaventure Formation.

The rocks constituting this formation extend in a continuous belt from the South-west Miramichi River above Boiestown, north-east to Bathurst, and appear at various points about the upper part of the Bay Chaleur. The limits of the formation are well defined on the North-west Miramichi, the Little South-west and Big Sevogle. About Bathurst it is seen well developed on the Nipisiguit River, whence it extends northward underlying the town and harbor and extending up and past the mouth of the Tête à gauche River, along the post road and to the mouth of Peters River, and occupying the coast to this point. Where ledges are absent the formation is readily recognized by its characteristic red soil. On the Nipisiguit itself it extends up about thirteen and a-half miles from the mouth, occupying, for the most part, the southern bank of the river Tête à gauche. Extent of the formation about Baturst.

while the granite occupies the bed and the northern bank. The red beds, however, at times extend past the north bank, but in such cases, owing to the low and wooded character of the country, the exact boundaries can not be made out. The beds, like those of the overlying Millstone Grit, have a nearly horizontal attitude or lie in gentle undulations, the inclinations not being greater than from two to four degrees. At the Rough Waters, three miles above Bathurst bridge, they are seen lying unconformably upon the granites; a layer of decomposed granitic *debris* intervening and probably constituting the lowest member of the Lower Carboniferous. This is overlaid by a thin bed of fine reddish conglomerate a few inches thick and capped by bluffs of dark-reddish gritty sandstone and shale. These about one mile below the railroad bridge, dip N. 80° E. $<$ 4°, but just above the road bridge four miles below, the dip is reversed to S.W. $<$ 2°.

Copper mine at Bathurst.

At this point a deposit of copper ore occurs, and has in former years been worked to a small extent. The ore, which is the green carbonate, resembles that noted as occurring in rocks of similar age near Dorchester, Westmoreland County. Similar deposits also occur on Mines Basin, N.S., all of which have been worked unsuccessfully. In all these cases these deposits are due to the action of organic matter upon solutions containing copper, by which the copper has been precipitated around the vegetable remains. Dr. Gesner in "Industrial Resources of Nova Scotia,"(1849), mentions several localities in the counties of Cumberland, Colchester and Pictou where similar deposits occur. He alludes also to the locality at Bathurst, and states that the ore occupied the site of a fossil tree, which had been transmuted into grey copper ore, and the removal of which exhausted the mine. He states also that the ore is frequently compact, although it is often filtered into a coal or lignite in which the vegetable texture of the original wood remains distinct. It is quite evident from this statement, as well as from the lack of success attending the operations on these deposits, that their economic value is but slight.

Bathurst to Little Belledune.

Going north from Bathurst along the coast, after passing Peters River, we find but small traces of Lower Carboniferous rocks till we reach Big Belledune Point. A very limited area, sufficient, however, to mark the deposit, occurs just above the mouth of the Nigadoo on the beach, and a larger area is observable on the Mill-stream, about half a mile west of the crossing of the Intercolonial railway. In character the beds in these localities resemble those seen at various points about the Bay Chaleur. Passing Belledune Point, just in rear of the Roman Catholic Church, horizontal beds of red conglomerate rest unconformably upon Silurian sandstones which dip N.W. $<$ 40°. Thence up to the mouth of the Belledune River the red beds occur at

intervals, in most cases the unconformable contact of the formations being plainly visible in the low cliff of this portion of the coast. The conglomerates which are associated with red marly shales, frequently contain pebbles of Silurian slates and limestone as well as bands of greyish calcareous nodules. Pebbles of the traps which are seen cutting the Silurian beds at many places also occur, and prove that the outpouring of these lavas was intermediate between the deposition of the Silurian and Lower Carboniferous formations.

Little Belledune to Jacquet river. Still going north and passing Little Belledune Point, which consists of sand and gravel, similar red beds to those just described extend up to the point above Jacquet River or nearly to Nash's Creek. Beautiful sections are observed in the cliffs about one mile south of Armstrong's Brook, where the Silurian beds of sandstone and calcareous slates are seen forming several sharp folds and cut by dykes of dolorite. These cliffs have a height of fifteen to twenty-five feet, capped by from ten to twenty feet of horizontal beds which lie equally over both the Silurian slates and the trap, the latter often taking the form of interstratified beds. From half a mile below Armstrong's Brook these red beds completely occupy the shore to above Jacquet River, extending back from half a mile to a mile from the coast and shewing in small cuttings along the line of railroad. North of the Creek above Jacquet River (Nash's Creek) the red beds do not shew again till we reach the point below River Charlo, the shore being occupied by conglomerates, slates, limestones and trap of pre-carboniferous age. **Heron Islands.** Heron Island, however, which lies off the mouth of Benjamin River, about two miles, is composed of soft red sandstones and conglomerates of this age, horizontal in position. These rocks resemble more closely the soft red sandstones of Triassic age of the Bay of Fundy than Lower Carboniferous sediments, but their stratigraphical relation to the Millstone Grit determines their age. These sandstones are dotted with numerous grey spots resembling sections of stems, which may possibly be caused by the decomposition of the red coloring matter by organic substances. Several curious fossil plants having peculiar jointed stems, with their fruits, were found on this island, as well as the footprints of a batrachian having five toes, which closely resemble those of the carboniferous beds of Nova Scotia These forms have not yet been determined.

From the mouth of the Charlo River, north, the red beds again occupy the shore as far as the bluffs which terminate the trappean ridges south of the town of Dalhousie. They are seen at low tide along the beaches about the mouth of Erl River and probably occupy the basin of this stream to the east of the railroad. Above Charlo they extend back from the shore only a short distance beyond the rail-

road, but stretch along the line of the Intercolonial from Charlo station to Dalhousie station, and spread out so as to form a considerable area at the latter point. They lap round the western spur of the hills about Dalhousie to the west of Pointe La Lime, and form the high ridges south of Dalhousie station which extend westward for more than a mile, or almost to Maple Green post office. They are exposed on the beach about one and a quarter miles west of the station at Dalhousie for a distance of 200 yards, and shew in a cutting at that point. On the shore they rest upon trappean rocks on the one hand and soft, Devonian shales on the other.

Coast opposite Dalhousie.

On the Quebec side of the Restigouche, opposite Dalhousie, the red beds of the Lower Caboniferous (Bonaventure of Sir Wm. Logan) are largely developed, and rise into high hills which extend from the mouth of the Scaumenac eastward to the mouth of the Nouvelle River. Above High Cape, which forms the bold headland at the mouth of the Scaumenac, no trace of this formation has been discerned, the shore being occupied principally by Devonian sediments. Between High Cape and Point Muguacha the red beds extend in an almost unbroken range of hills, but between Fleurant and Yacta Points they do not reach the level of the beach, but are seen to rest unconformably upon grey sandstones, shales and conglomerates, which have been found to be of Devonian age, and will be hereafter described. These red beds, as on the New Brunswick side, generally have a nearly horizontal attitude, but shew, at one or two points, local twists, which do not, however, affect the regular stratification of the beds to any great extent. The prevailing dip is mostly eastward at a low angle.

Stratigraphical position of the Lower Carboniferous Bonaventure formation.

In none of these localities do we find the same variety in lithological character as is seen in this formation in the southern part of the Province. As developed in this area the Lower Carboniferous seems to represent the upper member of the formation, and probably corresponds to the upper part of Division 5 of the Geological Survey Report 1876-7. Its position would, therefore, be between the gypsiferous series and the base of the Millstone Grit. The resemblance of these beds also to the upper part of the gypsiferous formation, of the same age, as developed on the Tobique River, tends to establish this conclusion, while their intimate association with the base of the Millstone Grit, and the apparent passage of the beds of the lower into the upper establishes very close relation between the two.

Devonian.

The principal areas under examination which have been shown to belong to this system, are those seen at intervals on the Lower Restigouche River, and which form a synclinal basin extending from

near the town of Dalhousie westward to a point about two miles above Campbellton, and terminating on the south side of the river at old Mission Point and on the opposite side at Pointe à Bourdeau. This basin is bounded on both sides by the trap ridges which enclose the lower part of the Restigouche, and against which the Devonian beds are seen to rest; and it conforms to the general outline of the hills. On the south side of the river Devonian beds are first seen near Pointe la Peuplier in the form of red sandstone and grey shales which dip N. 15° E. $<$ 35° or towards the river; whence, though interrupted at intervals by trappean masses, they extend up to a point about one mile west of Dalhousie station, the dips of the beds, while locally varying, are constant from the hills in the rear. At two points at least, Pointe Pin Sec and Pointe LaLime, beds of carbonaceous shale are seen, one of which has a thickness of ten inches, and has been for a long time regarded locally as a coal bed. Though containing sufficient carbonaceous matter to burn, it does not, however, fulfil the requirement of a true coal and has no economic value. An interesting feature at this point is the intrusion of a sheet of trap directly over the shale, to which it forms a roof. Associated with the sandstones and shales of this locality are several beds of trap conglomerate; the pebbles being of well-rounded trap cemented by a paste of trappean ash. Similar beds occur at various other points as at Pointe la Garde and on the Upsalquitch River. This kind of rock is quite common in connection with the Triassic traps of the Bay of Fundy. At several places the shales were observed to contain abundance of plant stems, psylophyton and others.

Extent of the Devonian basin of the Lower Restigouche.

Carbonaceous shale of Pointe LaLime.

From the exposure above Dalhousie Station to the bridge at Campbellton the shore is occupied for the most part with traps or dolorite of various characters; but at the bridge at Campbellton, large ledges of grey and purple slaty felspathic rock are seen dipping to the northwest or away from the ridge of the Sugar Loaf Mountain. These rocks are ashy in their composition and appear to be made up of the *debris* of the felspathic ash rock that form so large a portion of the trap region of this vicinity. They resemble, in many respects, the so-called claystones of Queens and Sunbury Counties, which have been regarded as basal beds of the Lower Carboniferous. They are frequently earthy and soft, and without any apparent stratification, especially towards the base of the series, and form a ridge lying to the back of the town of Campbellton and extending westward for some two miles. On the road north of Sugar Loaf Mountain they dip N. 60° W. $<$ 35°, but a reverse dip is seen near the west end of the snow-shed above Campbellton to S. 70° E. $<$ 20°. On the post road south of the shed these purple and grey, felspathic, ashy and slaty rocks dip S. 30° W. $<$ 63°. This peculiar kind of slate occurs only in the vicinity of Campbellton; and it is

Basal beds of the Devonian at Campbellton

probable these rocks underlie the coarse Devonian sandstones and grits which are exposed on the shore close by. The town itself is built largely upon trappean rocks, some of which have the aspect of stratified beds. They are highly crystalline dolorites, and the bedded structure is seen at a number of points in the vicinity of the Restigouche. The river in front of the town, from the steamboat wharf westward, is lined with Devonian rocks, generally grey in color, both sandstones and conglomerates. In the rear of the Royal Hotel these beds dip N. 25° W. < 25°–30°, but at the wharf the dip decreases in angle to 5°–10°. They exactly resemble the beds which are exposed on the Quebec side of the river, and at this place form the southern margin of a synclinal basin, the northern side being seen at Pointe à Bourdeau, about two miles above Cross Point opposite Campbellton, where the beds dip S. 20° E. < 45°. The conglomerates contain pebbles of limestone, slate, felsite, trap and jasper, and are interstratified with grey sandstones, which have been quarried in the vicinity of Pointe à Bourdeau for the Intercolonial railroad. Plant stems of Devonian type are common in the sandy and finer portions. Above the station at Campbellton hard thick-bedded sandstone, intersected by thin dykes of trap, contains abundance of fossil plants; a collection of which was made by Mr. T. C. Weston and examined by Principal Dawson. The following forms have been determined:

Synclinal basin at Campbellton

Fossil plants at Campbellton.

Psilophyton robustius.
" princeps.
" (fragments).
Lycopodites Campbelltonensis, n.s.
Cordaites angustifolia and stems (?) of same.

With a number of other specimens of psilophyton fragments. At a distance of 1800 paces west of the Royal Hotel ledges of hard grey limestone have been found by Mr. Weston to be largely made up of comminuted fossils.

Cross Point to Scaumenac River.

On the north or Quebec side of the river, Devonian beds apparently occupy the whole extent of the flat country lying between the base of the trap hills and the shore. They are well exposed at Cross Point, opposite Campbellton, where they dip N. 10°–20° E. < 10°. These beds are probably near the centre of the synclinal. Below this, exposures of similar rocks occur at Pointe la Garde and along the shore to near Battery Point. They are similar to those described at Pointe à Bourdeau, and like those of Pointe LaLime contain interstratified beds of trap conglomerate. The sandy layers contain abundance of plant stems, and the whole series dips southerly from S. 20° W. in the western exposure to S. 50° E. at Pointe la Garde, the angle of dip ranging from

5° to 75°. Thence they occupy the greater part of the shore down to the mouth of the Scaumenac River and lie in a nearly horizontal position or with a slight southerly dip, resting against the flanks of the trappean hills that stretch continuously along the north side of the river as far east as Nouvelle River. At High Cape the Devonian beds are concealed by the unconformably overlying red beds of the Lower Carboniferous (Bonaventure) formation which extend down along the shore to the western side of the cove above Fleurant Point, with outcrops of Devonian rocks at Pirate Head, and at Pirate Brook where reddish conglomerate with pebbles of grey limestone, associated with grey Devonian shale is seen on the beach, dip S. $<$ 50°, with accompanying sandstone. In the cove above Fleurant Point, however, the grey beds of the Devonian are again seen, both the conglomerate, similar to those of Pointe la Garde and sandy and shaly beds. These beds contain splendid specimens of Devonian fishes, some of which have already been described by Mr. Whiteaves in the *American Journal of Science*, August 1880. The beds are mostly flat or dip north-eastward at a low angle. At Fleurant Point the conglomerate also occurs, underlying the softer shaly and sandy beds, and dips N. E. $<$ 7°–15°. Rounding the point and entering the cove, we meet with the usual grey shales and sandstones containing abundant remains of fishes and plants, which dip N. 25° E. $<$ 10°. From this eastward to Yacta Point, the shore is occupied with Devonian beds, principally grey in color but in places a brownish-red, especially near their contact with the overlying red beds, dipping shoreward at low angles and forming cliffs from thirty to fifty feet in height, capped at the upper part of the cliff by horizontal red beds which here rise into ridges of 300 feet or more in elevation. At Yacta Point there appears to be almost a transition between the Devonian and Lower Carboniferous beds, but the conformability is more apparent than real, as is readily seen by observation of the beds between this point and Muguacha Head. The bold bluffs of Yacta Point soon sink down again, going eastward, and the grey beds again occupy the shore in low bluffs for several hundred yards, the red beds capping them unconformably and extending thence around Muguacha Point to the mouth of the Nouvelle River. Eastward of this river the grey beds have not yet been traced, but as they are said to occur on the Grand Cascapedia it is probable that in the intervening distance they are concealed by the Bonaventure formation which stretches along the shore to that place.

Scaumenac Bay

Fossil fishes.

Second outcrop of Devonian between Yacta Point and Muguacha Head.

The grey beds between Yacta and Fleurant Points are very rich in fossil forms of fishes and plants. Very valuable collections have been made from this locality, principally by Messrs. Foord and Weston,

the determination of which has not yet been concluded, and the results will appear in an accompanying report by Mr. J. F. Whiteaves.

Devonian beds of the Upsalquitch river.

The only other area in which Devonian rocks have been recognized is on the Upsalquitch River, about nine miles above the Forks. They consist of grey sandstones and conglomerates, the latter containing pebbles of white quartz, felspar, jasper, slates, etc., which resemble exactly the grey Devonian beds of the Restigouche already described, and lie unconformably upon the Silurian and trappean rocks of this area. They dip N. 50° W. $<$ 5°–7°, and extend down to seven miles above the Forks, but their extension eastward has not yet been traced, owing to the wilderness character of the country and the entire absence of settlements.

SILURIAN.

Distribution of the Silurian.

The rocks of this System occupy an extensive belt reaching across the entire breadth of the Province, from the State of Maine to the Bay Chaleur, and are at many points well marked by chacteristic fossils. In the eastern area they rest upon rocks probably of Cambro-Silurian age, which in their upper portions contain fossils (graptolites) of presumed Hudson River type, as well as imperfectly preserved brachiopod shells, and they extend in a broad sheet over the entire northern part of the Province and across the boundary into Quebec, forming a wide geosynclinal basin about 100 miles in breadth, the northern margin of which rests upon the rocks of the Quebec group near the river St. Lawrence.

Superposition on the Cambro-Silurian.

Along the Upsalquitch and lower Restigouche Rivers they are broken up or cut through by dykes, often of large size, of trap (dolorite) and felsite which about the mouth of the Restigouche are quite extensively developed, and form very prominent features in the landscape. The southern margin of the belt has been traced as well as the sections afforded by the various rivers followed, from the St. John River eastward to the Bay Chaleur. On the St. John River the calcareous and sandy beds characteristic of the formation are well exposed about the mouth of the Tobique River, a branch of the St. John. At the former point as well as along the river northward the slates are nearly vertical and strike N. E. and S. W.

Silurian beds on the Tobique river.

At the Narrows, a deep rocky gorge about half a mile from the mouth, they are much broken and slightly faulted, and contain frequent bands of white calcite along the lines of stratification. The dip above this continues northwest for about six miles or to the mouth of the Little Pokiok, the angle varying from 40° to 70°, the slates becoming more marly with minute scales of mica. Occasional hard bands mark the stratification of the beds. Just above the mouth of this stream the dip is reversed to S. 40° E. $<$ 35°. Thence up to a brook about two and a-half miles below Trout Brook

the beds are well exposed, the dip remaining the same. At this point ledges of reddish conglomerate with thin bands of reddish limestone, lying in horizontal beds, come in and cover the Silurian strata. Just at the sharp bend below Red Rapids, a large dyke of greenish moderately coarse dolerite occurs, having an exposed breadth of about 140 feet, passing which no ledges are seen, the country being flat till the foot of the Red Rapids is reached, when the red beds of the Lower Carboniferous (Bonaventure) formation again occur. Thence up stream the river and the surrounding country on both sides for some distance is occupied by Lower Carboniferous rocks till we reach Blue Mountain Brook. This area constitutes the Tobique Lower Carboniferous outlier, and has been described in former Reports by Mr. Charles Robb, Prof. Hind, and others. About two and a-half miles above Blue Mountain Brook, Silurian grey, sandy and calcareous slates come in on the northern side of the river, dip S. 20° E. $<$ 45°–50°, the south bank showing high bluffs of felspathic rock. At the mouth of Riley Brook the grey, sandy and micaceous slates of this age are seen on the south side of the river with a dip of S. 35° E. $<$ 75°. They extend back from the shore for only a short distance, the hard felspathic rocks noted as occurring below forming a marked elevation to the south. From this upward to the Forks of the Tobique the river flows over Silurian slates.

Lower Carboniferous outlier of the Tobique.

The Forks of the Tobique are formed by the junction of the Nictor or Left Hand Branch and the Campbell or Right Hand Branch. On the latter stream, which flows from the south, Silurian rocks are recognized for some distance. Ascending this branch calcareous slates dip N. 25° W. $<$ 20°–40° and extend for two and a-half or three miles to huge ledges of green chloritic slates and moderately coarse diorites, which have a surface breadth of nearly a mile, and are succeeded by bluish-grey slaty rocks dipping up stream S. 10° E. $<$ 10°. These at the Lower Falls abut against a ridge of grey and green pyritous felspathic rocks which probably bounds the Silurian in this direction, the rocks above this on the river belonging to the metamorphic pre-cambrian series.

Limit of the Silurian on the Right Hand Branch or Campbell river.

The Nictor, or Left Hand Branch of the Tobique, is occupied entirely by Silurian rocks. These for several miles above the Forks are somewhat broken and thrown into sharp anticlinal folds, but the prevailing dip is north-westerly (N. 20° W.) At about five miles from the Forks the rock exposures cease; the banks become low and shew no ledges for about twenty miles, when dark grey micaceous and irony slates are seen, dip S. 50° E. $<$ 60°. Ranges of hills extend along both sides of the river at a distance of half a mile or more, but the banks are densely wooded, principally with cedar. From this to the outlet

Silurian of the Nictor or Left Hand Branch of the Tobique.

of Nictor Lake at the head of the stream, the exposures are few, but the general dip is S. E. < 50°. The lake marks the limit of the Silurian formation in this direction, the southern shore being occupied by green chloritic slates and slaty talco-felspathic schists which dip N. 85° W. < 90°, while a large mountain of red crystalline and porphyritic felsite rises abruptly from the water to a height of over 2000 feet, and stretching away in a long ridge to the south-west probably defines the southern margin of the Silurian in that direction. The talco-schists flank the northern base of the mountain and dip away from it at a high angle. The difference between the Silurian rocks of the Tobique and the crystalline schists of the lake is well marked both by the mineral and metamorphic character of the latter.

Limit of the Silurian on Nictor lake.

Upper part of the Upsalquitch river.

From Nictor Lake to the Upsalquitch the Silurian formation has not been traced owing to the densely wooded character of the country, but on the latter stream good sections are afforded for about thirty-one miles directly across the strike. After leaving the lake at its head the river runs in a very crooked and narrow channel nearly to the falls, a distance in a straight line of about six miles. The banks are low and swampy, and no ledges appear till we approach the mouth of the Little South East Branch. Here grey-mottled felspathic rocks (Gabbros) are followed down the stream by purplish, grey, slaty and dioritic beds, veined with yellowish-green epidote. Thence to the upper end of the falls frequent ledges of hard dense grey slates or quartzites, weathering a rusty-brown and breaking into angular pieces, no dip discernible, occur. At the falls, a ragged gorge a mile or more in length, the rocks are hard green conglomerates with pebbles of reddish and grey slates and felsites and a few of grey limestone; the dip at the upper part is not clearly defined, but at the lower end, about three-fourths of a mile above Ramsay's Brook, it is N. 10° W. < 75°. These rocks contain indistinct traces of fossils, crinoids, corals and minute brachiopods. The paste of the rock is dark green and ashy looking, thickly studded with minute pieces of comminuted slate. At the lower end of the falls the conglomerate is mainly composed of small pieces of grey and red slate. It dips down stream at a high angle and underlies the slaty and sandy beds, which are well developed in the vicinity of Ramsay's Brook. At the mouth of this brook they dip S. 20° E. < 70°–90°.

Gabbros.

Fossils.

Going down the river the slates maintain a southerly dip, the angle gradually decreasing to 50° at Big Brook. Below this for some distance the rocks are ochreous on weathered surfaces and are very calcareous, approaching a limestone. They contain imperfect remains of brachiopod shells and crinoid stems. Just above Meadow Brook the regular sandy greenish grey slates shew on the west bank, dipping S. 10° E. < 70°, and are underlaid by light-green chloritic grits and fine

conglomerates, which in turn rest upon hard crystalline felsites of the same aspect as those seen on the upper part of the Nipisiguit. This structure would indicate the existence of a synclinal in the Silurian rocks at this point. After passing the felsite hard green epidotic rocks extend down for nearly a mile, and are overlaid by the grey grits and conglomerates of the Devonian already described. This is at Ten-mile Brook.

No Silurian rocks are then seen as we descend the stream till we reach six and three-quarter miles above the forks of the North-west Branch, the intervening space being occupied by Devonian rocks and amygdaloidal traps and dolerites. At six and three-quarter miles ledges of grey, flaggy sandstone, dip S. 40° E. < 30°, appear again and are associated with soft, splintery and marly shales, same dip. At five and a-half miles a high hill of fine grey, with shades of ochreous-brown, thin-bedded shales occurs, underlaid at the water's edge by hard dark-green dioritic looking rock, and containing near the contact a small seam half an inch in thickness, with fossil corals; and half a mile below grey marly shales, overlaid by hard rusty quartz or sandstone, are seen, containing abundance of corals and brachiopods, dip S. 25° E. < 20°.

Amygdaloids and dolerites.

Devonian outlier.

Just above the four-mile tree several dykes of red porphyritic felsite and others of porphyritic diorite, one of which has a breadth of twenty-five feet, are seen cutting the slates and disturbing their bedding. Near the three and a quarter mile bend or ox-bow, ledges of brick-red felspathic rock are seen, probably an extension from a high peak of felsite a short distance west of the river at this point. They extend down to two miles above the Forks, and contain at one point a bed of trap conglomerate similar to that seen on the Restigouche River. This shews also on the North-west Branch, about seven and a-half miles from the Forks. Below this to the junction with the North-west Branch, grey sandstones and slates of the usual Silurian type occur, dipping S. 20° E. < 75°.

Felsite dykes in Silurian rocks.

An ascent of the North-west Branch, for sixteen miles, disclosed nothing but Silurian sandstone and slates, with the exception of the ledge of porphyritic trap conglomerate noted above. The beds, dip S. 20° E. < 45°–70° for the first eight miles, and then N. 15°–20° W. < 70°, which dip they pretty constantly maintain as far up as our explorations extended.

Between the Forks and the mouth of the Upsalquitch, the Silurian rocks are continuous and occur in a series of folds which are cut by frequent dykes, generally of flesh-red felsite, porphyritic with crystals of pale red felspar, but in places a cream-white in color. They range in thickness from a few inches to over a hundred feet. Limestone

Felsite dykes

2

bands occur at intervals, and a great part of the slates are more or less calcareous. The beds are often disturbed by the intrusion of the dykes, though disturbances often occur when no dykes are visible.

Upper Restigouche River.

The description of the Restigouche from Metapedia to Patapedia has been already given by Mr. Richardson (Report of Progress, 1858, page 115). The rocks are all Silurian, sandstone, slate or limestone. Above this to the Waagun or crossing to the River St. John, the Restigouche flows apparently along the crest of an anticlinal, the rocks dipping S. 20° E. to N. 20° W. < 30°–60°. Exposures are not numerous, but when seen are all calcareous slates, soft with harder bands. Above the Kedgewick, the country in the vicinity of the river is generally low and the banks often swampy and bushy. The land in this section of the country should be well adapted for agricultural purposes.

Terraces.

Beautiful terraces are observed at several points. On the Upsalquitch, about three miles from its mouth, four very perfect ones were seen. At the Chain of Rocks Brook on the Restigouche three perfect and one irregular one were noted, and at the forks of the Kedgewick two perfect ones occur. The usual height of the terraces is about ten feet each.

Restigouche to the St. John River.

At the crossing from the Restigouche to St. John by the Waagun and Grand Rivers, only one rock outcrop was seen. This was on the Grand River, about eight miles from its mouth, dip S. 10° E. < 40°. The portage, which is about three miles in length from the head of the Waagun to the Grand River, is mostly low and shews no exposures.

Upper Tête à Gauche.

Between the Upsalquitch and the head of the Tête à Gauche River the country is almost inaccessible, being an unbroken densely wooded wilderness. An examination was, however, made of the latter stream to a point about six miles west of the upper lake. Here a ridge of grey and bluish-grey felpathic slates, lithologically resembling the Silurian of the southern part of the province, was found, but no fossils were observed. They probably are the equivalents of the grey beds seen in the Nigadoo River, and form the basal beds of the series. They dip N. 20° W. < 55°. Just below the outlet of the first Tête à Gauche Lake ledges of reddish conglomerate, filled with corals of Silurian aspect, rest unconformably upon the metamorphic schists of the Tête à Gauche River to the south. Their limits cannot be traced, and they may be simply an outlier of Silurian rocks.

Fossils of Silurian outlier.

Southern limit of Silurian.

Near the coast, slaty and sandy beds containing fossils are seen in the Nigadoo River, and on the roads in the back settlements in that vicinity. At the falls in this stream the rocks also contain fossils, but the forms cannot be determined. They probably represent the upper member of the Cambro Silurian, as just above the mouth of the river on the coast, the calcareous beds of the Silurian are seen overlying them.

It may therefore be stated generally that the Nigadoo River forms the southern boundary of the Silurian rocks in this direction.

Along the shore north of the Nigadoo River the beds constituting the base of the Silurian occur just above the mouth of that river. Between this and the Elm Tree River they are well exposed, and consist of calcareous and sandy slates, with bands of brownish-rusty conglomerate and some limestone. They are a good deal broken up, the dips indicating frequent anticlinals. North of Elm Tree River the limestone is considerably developed and in places very rich in fossils, crinoids, corals and brachiopods. Among the corals *Halysites catenulatus* and *Zaphrentis,* are abundant, as also *Strophomena rhomboidalis* and many brachiopods. These beds extend up the coast for about one mile above the mouth of the Elm Tree River till they are met by huge dykes of green epidotic diorite. The conglomerates which occur at Church Point and below the mouth of Elm Tree probably constitute lower members of the system.

Fossils at Elm Tree River.

The railroad though it affords but few cuttings between the Nigadoo and Elm Tree Rivers, yet shews in the trenches alongside several outcrops of Silurian slates and limestone. About half a mile north of Petite Roche station, one of these outcrops seen in a pit shows the limestone altered to a crystalline marble, but still retaining traces of crinoid stems. Crystalline limestones are more plainly seen on a road running just a short distance below Elm Tree crossing. Here, about three-fourths of mile beyond the railroad, quite extensive beds of marble, whitish-grey in color, are found in immediate proximity to large masses of diorite, but in all cases so far as the surface quarries have exposed the rock it is extensively shattered, and does not give much promise of workable beds. The alteration is also quite local, and the crystalline portion changes abruptly into ordinary grey fossiliferous limestone. At the Elm Tree crossing the diorites are well exposed and occupy a large area extending almost continuously nearly to Belledune station, cuttings being frequent. Only one small exposure of red slate was observed on this portion of the railroad, but on the shore extensive ledges of brown, hard conglomerate occur, which appear to be hardened by the action of the intrusive rocks. Fossiliferous beds of Silurian slates also occur on the shore, but these exposures partake of the nature of lenticular basins. In the vicinity of Belledune post-office the calcareous beds are again well exposed, and contain abundance of fossils similar to those of Elm Tree.

Marble of Elm Tree River.

North of Belledune Point the shore is for the most part occupied by Silurian limestones, slates and sandstones, though frequently capped by the newer red beds of the Lower Carboniferous already described,

and broken by occasional dykes of diorite and trap, to the vicinity of Black Point. At several places the calcareous portions contain abundance of fossils. Below Armstrong's Brook they form the lower portion of cliffs which are unconformably capped by horizontal sandstones and conglomerates. They are frequently faulted and cut through by dykes of trap and inclined often at high angles. Between Nash's Creek and Black Point the limestone is said to form excellent material for cement. Limekilns also exist at several points along the shore to the south. Black Point consists principally of trap, which forms a dyke of considerable thickness, between which and Beaver Point the fossiliferous Silurian beds again come in and form an anticlinal arch. Thence to the mouth of New Mills Brook, the shore and railroad show almost continuous exposures of trappean rocks, with interstratified beds of reddish-brown conglomerate, hard and evidently altered by the intrusive masses. From New Mills Brook to the mouth of Louison River the calcareous beds seem to be wanting, the rocks being mostly hard altered conglomerates which, on the small island opposite New Mills station, show an anticlinal structure. Trappean beds again come in and extend with only two small bands of Silurian along the railroad to within one and a quarter miles of the Charlo River, whence they probably continue northward, but are overlaid along the coast by the horizontal red beds of the Lower Carboniferous.

Belledune to Charlc River

North of Charlo station the back roads show alternate ledges of Silurian slates and trappean rocks, the latter greatly predominating, but the surface is largely covered by drift till we meet the bold ridges lying to the south of the town of Dalhousie. Good sections are afforded across the trappean ridges and Silurian beds which lie in the intervening depressions both on the road leading south from Dalhousie and along the shore around Bon Ami Point. From the town to the Eel River flat no less than five distinct ridges of trap can be seen. They have a course nearly east and west, and the depressions are occupied by wedge-shaped areas of Silurian rocks which are highly fossiliferous. The contact of the Silurian with the trappean rocks is well seen in the fine section afforded by the shore, and the relative age of the two sets of rocks can be easily made out. The Silurian rocks, limestones and slates show a marked alteration near the contact with the dykes, and at one place the traps have enclosed a fossil from the Silurian calcareous beds. It would thus appear that although the traps have an apparent bedded structure with the fossiliferous strata, they have been thrust up along the lines of bedding subsequent to the deposit of the Silurian rocks. The dip of the Silurian beds at Bon Ami Point is N. 50° E. $<$ 50°, but this changes towards the Eel River flat to N. 15° E. $<$ 45°.

Trap ridges at Dalhousie.

Fossils in the trap of Bon Ami Point.

South of the trap ridges which run along the south side of the Resti-

gouche river, between Dalhousie and Glenlivet settlement the country becomes less broken and is occupied by Silurian beds. These are exposed at intervals on the long straight road leading west from Eel River to Balmoral and Blair Athol settlements, as well as on the north branch of that river, about two and a-half miles west of Shannonvale post-office at the Eel River Forks. On the former road the dip, which is S. $< 45°$ in its eastern part, becomes reversed further east to N. 15° W. $< 60°$, indicating that this road follows for the most part the crest of an anticlinal. At the latter locality the dip of the calcareous, sandy, micaceous slates is N. 10° E. $< 60°$, or nearly the same as on the coast south of Bon Ami Point. From the Balmoral road the Silurian beds strike across to the Upsalquitch River, which has already been described. Exposures, however, are not numerous in this part of the country owing to the enormous covering of drift clays and gravel which extend from the Restigouche River to Bathurst, and are exposed in many of the cuttings along the line of the Intercolonial railroad. **Country south of the Restigouche.**

On the Restigouche, in its lower part, no exposures of Silurian rocks are met with till we reach Morrissey tunnel, about four miles below the mouth of the Metapedia River. The basal beds at this place rest upon the high spur of dark blackish-brown and grey amygdaloidal and brecciated trap, through which the tunnel is pierced, and consist of fossiliferous grey sandy beds with interstratified beds of limestone conglomerate, the pebbles mostly of grey limestone, lenticular or roughly rounded in shape, cemented with a brown calcareous paste. On the north side of the tunnel these beds dip N. W. $< 75°$, but in the course of a few hundred yards the dip is reversed to S. E. $< 45°$, forming a narrow synclinal basin. Above this another ridge of hard green diorite comes out to the post road, and continues for nearly half a mile whence Silurian rocks extend up to the Metapedia. **Junction of trappean rocks and Silurian.**

The Glenlivet settlement and the road thence through Dawsonvale to the mouth of the Upsalquitch are occupied by Silurian rocks. On this road, about midway, the dip is N. 40° E. $< 40°$, while on the post road at the forks of the road to Glenlivet it is S. 70° W. $< 50°$. As we approach the Restigouche bridge the dip again becomes reversed to N. 50° W. $< 60°$–80°, bending round on the Quebec side more to the west or N. 60°–70° W. $< 50°$. **Glenlivet.**

On the north side of the Restigouche, Silurian slates and limestones were observed from the mouth of the Metapedia to a point nearly opposite Morrissy's tunnel, or seven and three-quarter miles above Cross Point, opposite Campbellton. Here they are cut off by the traps of the north side of the river and do not occur again along the shore to the east. On the Scaumenac River, however, about one mile above the bridge, Silurian rocks, limestones conglomerates and fossiliferous breccias, are seen forming a len-

ticular area enclosed by high ridges. The description of these trappean ridges is given in the Report of Progress, 1843, by Sir W. E. Logan, and will be discussed further on. Similar conglomerates and limestones are reported on the Scaumenac and Nouvelle Rivers on the north side of the trappean ridges, but their examination in this area has not been completed.

Cambro-Silurian.

The area which we propose to include in this system embraces, as in the southern part of the Province, a considerable variety of rocks, many of which are highly metamorphic and all more or less altered, but not apparently from local causes as is so plainly to be seen in the Silurian strata already described. Fossils, which however are very imperfect, are found at several points, but the determination of the age of this system has been based principally upon lithological and stratigraphical evidence. It may in general be stated to form a continuous belt of several miles in width, extending from the mouth of the Nigadoo River, on the Bay Chaleur, to the main South-west Miramichi, beyond which our explorations have not been extended in that direction, but it appears evident from the work of Mr. Charles Robb (see Report of Progress 1866-69) and that of Prof. Bailey and Mr. Broad in the county of York, not yet published, that similar rocks stretch across the entire breadth of the country to the Maine boundary, and that they are, in part at least, the equivalents of the so-called Cambro-Silurian of Charlotte county, as described in the Report of 1878-79. In the area bordering on the Bay Chaleur they have been well recognized on the Nigadoo, the Millstream, the Tête à Gauche and the Nipisiguit Rivers. They are well developed on the North-west Miramichi and its several branches, and on the Little South-west, while on the main South-west Miramichi they form a broad belt, broken up by several masses of granite, but containing imperfect fossils at one point at least near their southern margin. In all these places the general lithological characters of the group are maintained, and certain belts can be traced continuously. As a group they rest unconformably on a series of felspathic gneisses and crystalline schists, many of which resemble the pre-Cambrian rocks of the southern portion of the province, described in the Report for 1878-79. Brief descriptions of some of these rocks as seen on the Nipisiguit and elsewhere are given in Professor H. Y. Hind's Report to the New Brunswick Government (1865), but no attempt was at that time made to separate the Palæozoic systems from those of pre-Cambrian or Archean age, all being included under the general term Quebec group, a similar classification being made in the southern part of the province. Subsequent investigations in that area, however, have

General distribution of the Cambro-Silurian.

Former work in these systems.

shewn that the rocks there are divisible into two distinct and widely separated portions; the better settled character of the country affording fair facilities for their determination. The northern portion of the province, however, is for the greater part entirely unsettled and an almost unbroken wilderness, densely wooded and accessible only by canoes in summer or on snowshoes in winter, so that accurate delineation of boundary lines is almost an impossibility. The sections afforded by the various streams, however, have enabled us to pronounce with a fair degree of accuracy on the limits of the various systems.

Northern limit of Cambro-Silurian.

The most northerly recognized exposures of Cambro-Silurian rocks is seen on the Nigadoo River. On this stream, at various points upward from its mouth, ledges of grey, sandy and fine-grained slates occur, with darker thin bands of fine slates and coarser sandy beds, cut by frequent veins of white quartz which contain traces of copper, iron pyrites and galena. These rocks are considerably altered and are lithologically different from the overlying Silurian beds, though in places they are apparently conformable in dip. At several points on this stream, as at the Falls and the crossing of the back settlement road, indistinct fossils are found, but their forms are not well enough preserved to determine their age with certainty. On the Millstream, the next river to the south, at the Intercolonial railroad bridge, ledges of greenish and purple brown slates are seen resembling those seen in the Tête à Gauche. Fossils could not be determined definitely in these rocks, but certain weathered depressions occur which may indicate their existence. These slates are somewhat ashy in their texture, and contain abundance of minute kaolin specks, and on the Tête à Gauche are associated with soft, black and graphitic slates which hold abundant impressions of graptolites. Half a mile above the railroad bridge on the Millstream, Lower Carboniferous red conglomerates occupy the stream for a short distance, resting upon greyish felspathic and slaty rocks, sometimes calcareous and with minute specks of pellucid quartz, the rock at times schistose and soft, purple in color and ochreous from the decomposition of iron pyrites. At the Lower Falls, near the road crossing, about one and a half miles from the railroad bridge, the rocks change to a felspathic conglomerate, the paste being coarse and gritty, and weathering a reddish grey. These, however, contain slaty bands, the dip of the whole being apparently south, the angle doubtful. Through the back settlements of Dumfries, St. Louise and Robertville, these rocks are associated with greenish dolerites, moderately coarse, and in the vicinity of Dumfries church they dip S. 10° W. $<60°$. On the straight road south from Dumfries ledges of hard greenish and greyish dolerites occur near the crossing of the road to Dunlop settlement, but on this cross road, about half way, at the bridge over Grant's Brook, large

Graptolites of Tête à Gauche.

ledges of grey micaceous and well banded slates dip N. 20° W. <70-90°, associated with very rusty black and pyritous beds. These extend down Grant's Brook, and are much broken and twisted, probably from the presence of dykes of dolerite. They are probably the equivalents of the black and red manganese bearing slate seen further south on the Tête à Gauche, and which can be traced across the country to the main South-West Miramichi.

Concretionary doleritic rocks.

Between Grant's Brook and Peter's River along the railroad the several cuttings disclose principally doleritic rocks, often highly felspathic and in places concretionary, the concretions varying in size from six inches to several feet, and in broken surfaces disclosing a circle of small holes in dots around the outer margin.

These rocks form a low and irregular ridge, and at several points carry thin veins of red hematite, which, however, was not observed in quantity sufficient to be of value. Passing Peter's River, which flows for the most part over rocks of this character, we reach in a short distance the Tête à Gauche, which for its entire length affords good exposures from near its mouth to the lakes, a distance of about 30 miles, the greater part of which distance is over rocks of presumed Cambro-Silurian age. These rocks first make their appearance on the post-road, about one quarter of a mile north of Peter's River, dipping S. 5° W. < 55°, whence they extend westward. On the Tête à Gauche red Lower Carboniferous rocks occur in the bank below the railroad bridge and just above the crossing of the post-road, but at the railroad beds of grey and purple ashy slates, similar to these seen on the Mill-stream, are associated with the graphitic black slates containing graptolites already mentioned, and which, although their forms have not yet been definitely determined, owing to their poor state of preservation, closely resemble similar forms found in the Quebec group of the Gaspe Peninsula. These beds therefore probably mark the upper portion of the Cambro-Silurian system at this point. Similar ashy beds, associated with others, grey and sandy, extend up to near the falls, being well developed in the vicinity of the mill, but no other fossil remains could be discerned. At the falls, about eight miles from Bathurst, reddish and green slates which form a conspicuous and well-defined part of the formation are seen. The reddish beds contain considerable manganese in the form of small nodules, and the rock was at one time quite extensively but unprofitably worked for this mineral, as well as for copper. The manganese bearing character of this belt is an important element, and serves to define the formation throughout its extension to the south-west, being easily observable at a number of points. These are associated also with black, rusty and

Tête à Gauche River.

Manganese mine at Tête à Gauche falls.

manganese stained slates, which are also easily recognized over a large area as an integral part of the formation. They are doubtless the same as those seen on Grant's Brook, previously noted. They are frequently minutely wrinkled or covered with fibrous markings on the surface, and often much crumpled and disturbed. These two sets of beds, the red and black slates, very strongly resemble in lithological character some of the slaty beds of the so-called Quebec group. Between the falls and the narrows, about six miles further up stream, the black and manganese-stained slate predominates with occasional red beds, as at the falls. At the narrows they are met by a heavy band of mottled green diorite, about seventy-five yards in width, cutting the slates which here have a strike of N. 60° E. Thence up to Armstrong Brook, about three-eighths of a mile, black slates cut by diorites occur. Above this brook, for nearly a mile, few exposures are seen, with the exception of another heavy ridge of green diorite about mid-way, but at this point ledges of grey and graphitic sub-crystalline limestone occur. They appear to form a portion of the black slate group, and are associated with greenish and blue calcareous slates, which dip N. 50° W. $<$ 65–90°. These limestones occur at intervals for several miles, sometimes with hard green massive chloritic and epidotic diorites and at others with black manganese-stained slates. Their crystalline character may be due in places to local alteration from the presence of the diorites, as in the case of the Silurian marbles of Elm Tree River, already mentioned, and may be repetitions of the same bed brought to the surface by folds. Their extension along the strike could not be traced owing to the wooded character of the country, but they have apparently a strike of N.E. and dip at a high angle, 80°. Above this, or about one mile below the South Branch, the black slates cease, and the stream is occupied with soft greenish talcose schist, dip E. $<$ 55°, and cut by frequent veins of white quartz. This probably marks the northern limit of the Cambro-Silurian in this direction, the two sets of beds being apparently unconformable, though actual contact could not be seen. Thence up to the upper falls, about one mile below the first lake, talcose and chloritic schists, often felspathic, extend till they are covered by the fossiliferous Silurian beds below the outlet of the lake.

Sub-crystalline limestones of the Tête à Gauche.

Northern limit of Cambro-Silurian.

The road leading up the Tête à Gauche River, on the south side, shews, above the falls and in the Rose Hill settlement, the same series of black iron and manganese-stained slates, already described as occurring on the stream. At the eight mile post, near the falls, there are ledges of grey schist with quartz veins, dip S. $<$ 50°, with a similar dip, also, grey quartzites and purple or reddish dark mottled

rock resembling a schistose conglomerate which are doubtless a part of the series.

Between the Tête à Gauche and the Nipisiguit the only other stream shewing exposures is the Middle River. After passing the granite, which extends up about five and three-quarter miles from Bathurst, ledges of purple grey and felspathic schist are seen on the road alongside the stream, with a local strike of N. 35° W. Ridges of grey quartzite and dense fine grained diorites also occur, but the exposed breadth is not more than a couple of miles, the dense covering of drift concealing from view the underlying rocks over the greater part of this area. Perhaps the best section of these rocks is that afforded by the Nipisiguit River. On this stream, after passing the granites, which extend up to a distance of eleven and three quarter miles from the bridge at its mouth, a pretty continuous series of rocks, presumably of this age, are seen for about thirty miles, in which, however, great diversity of character exists, and it is quite possible, as in the area in Charlotte county, that other and older beds may be represented. After passing the granite, which forms the bed of the stream for about nine miles, the first rocks met with are reddish-grey micaceous and schistose slates, frequently clouded with purple and containing red stains and small strings of probably the red oxide of copper. They are a good deal disturbed, but dip generally S. 40° E. < 55°. On the south side of the river, at the 13-mile tree, these rocks have been worked for copper, the locality being known as the "Baldwin Copper Mines." They here contain a small amount of copper pyrites in quartz veins, but the rock is much broken and shattered, so that the dip is not determinable. Fresh surfaces are frequently striped or banded with yellowish-grey colors. A quarter of a mile above are ledges of bluish-grey or dark-grey schistose slates, which gradually shade off into the black ferruginous slates similar in aspect to those described on the Tête à Gauche. Just above the head of Round Island these become more schistose, resembling those seen below at the mine, and dip S. 80° W. < 75°. Ascending the river to the Middle Landing Falls (14 m.) we pass over a succession of schistose and slaty rocks, sometimes black and irony, at others grey and quartzose. At the foot of these falls the slates and schists are highly disturbed, hard and cut by quartz veins. They also contain beds of highly crystalline felspathic schist, dipping S. 70° E. < 70°-90°. which here form a sharp anticlinial and are much twisted along the axis. The schists weather rusty from the abundance of iron pyrites, and are flanked on the north side by the ordinary irony black slates, dipping N. 70° W. < 75°, which extend up stream, forming low ledges along the shore to near the 16-mile tree. Above this to the Chain of Rocks, greenish-grey slates, often massive and quartzose, occur which

Nipissiguit River.

Baldwin Copper Mine.

at the Chain dip W. < 45°. Hard green quartzites extend thence to near Gilmore's Brook, where they are succeeded by dark irony slates similar to those seen below. They also dip W. < 45°, and continue up to the narrows below Grand Falls, becoming schistose and more altered, with irregular veins of quartz often rusty. The Narrows is a deep gorge through schistose and slaty rock, with bands of talcose and mica schist, and extending from the basin to the head of the fall, about three-quarters of a mile. Some of the beds contain abundance of iron pyrites, which give the rusty character to the rock, and the surface of the schists is sometimes dotted over with scattered specks of clear quartz. They are frequently crumpled and all highly altered.

Narrows of the Grand Falls.

From the head of the Grand Falls (20¾ m.) the rocks are mostly felspathic and schistose, with a general westerly dip, and resemble in some respects the Pre-Cambrian rocks of the southern coast. This may, however, be due to the more highly altered condition of this portion, as they are intimately associated with the red and black manganese-stained slates, and appear to form part of the same series. The Upper Narrows is a rough gorge of nearly half a mile in length, through green chloritic and felspathic slates and schists, cut by veins of rusty quartz, dip generally N. 35° W. < 45, but much distorted. Between the head of the Narrows and the Nine-mile Brook (31 m.) the rocks are silico-felpathic, slaty and schistose, and just below Nine-mile Brook dip W. < 75°. They are directly succeeded at this point by the black and rusty Cambro-Silurian slates of the Tête à Gauche, which apparently conform in dip with the underlying silico-felspathic beds, but it seems probable that the rocks in the stretch between the Upper Narrows and the Nine-mile Brook may belong to the older or Pre-Cambrian system and form an extension of the felspathic gneisses seen in the S. W. Miramichi. On the Nine-mile Brook, about two miles from its junction with the Nipisiguit, red slates of the usual type with nodules of manganese occur, which are doubtless continuous with those at the Tête à Gauche falls. Above the Nine-mile Brook black thin bedded slates extend up to 36½ miles, when hard green schistose and slaty felspathic rocks again come in and occupy the stream to near the mouth of Forty-mile Brook associated, however, with black slates at several points. Above this the rocks are hard, green and more siliceous; which character they maintain to within a short distance of the Indian Falls, where they are terminated by grey schistose felspathic gneisses, weathering reddish and dipping E. < 60°. These probably mark the western limit of the Cambro-Silurian rocks in this direction.

Upper Narrows

Probable pre-Cambrian axis.

Western limit of Cambro-Silurian on the Nipisiguit River.

The frequent recurrence of the well-marked bands of red and black slates on this stream indicates a somewhat extensive series of anticlines,

Anticlines and synclines.

the axes of which would be probably represented by the hard, green chloritic and siliceous bands, described as occurring in connection with this group of rocks, while the synclines would be indicated by the softer slaty portion. Throughout the whole extent, although diligent search was made, no trace of fossils could be found—but the group as a whole is manifestly distinct from the highly crystalline gneisses and other felspathic rocks which occupy the country between the Indian falls and the lakes at the head of the river. And we have little hesitation in pronouncing these rocks to be newer than, and to lie unconformably upon, the Pre-Cambrian series presently to be described.

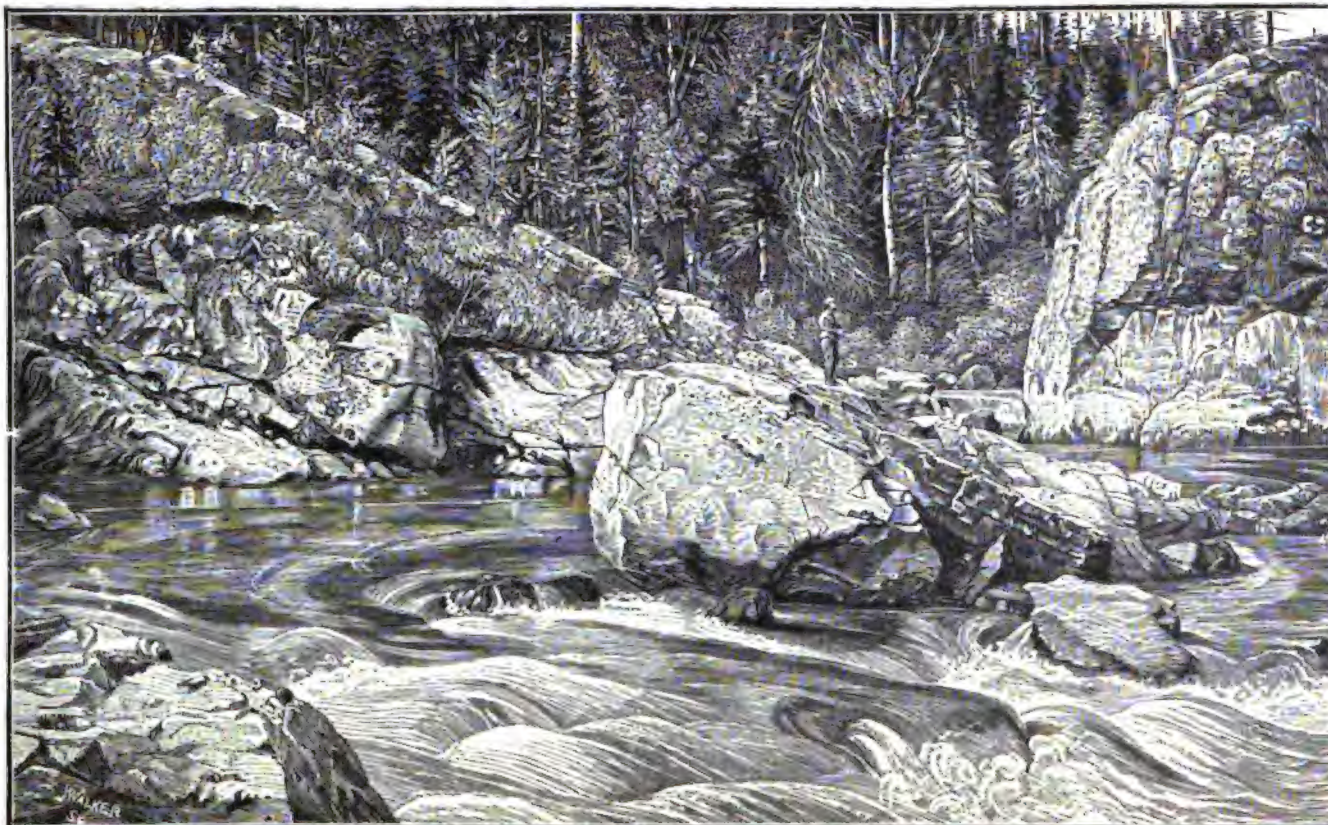
Persistent band in the Cambro-Silurian.

Between the Nipisiguit and the main South-West Miramichi River, the characteristic black and manganese-stained slates have been traced and are found to constitute a persistent band. Good sections across the beds are afforded by the North-West Miramichi and its branches, the Sevogle and Little South-west. The grey and green quartzites and schists seen at the Grand Falls of the Nipisiguit are also well marked in all these streams. In all cases they apparently, as a group, rest unconformably upon felspathic gneisses of a much older system. On the main South-West Miramichi, the green and red slates holding nodules of manganese like those of the Tête à Gauche falls are associated with beds of greyish slates, highly cleaved and containing fossils which, however from their distorted character cannot be determined, but appear to be more nearly allied to Cambro-Silurian than to Silurian forms. The rocks on this stream are much affected by granite masses, which in places have altered the strata in contact for several feet, and produced crystals of staurolite and mica in the surrounding beds. They do not, however, seem to belong to the oldest metamorphic belt, as they consist largely of quartzites and slates, till we approach the Forks, where at a distance of about four miles below we find genuine micaceous gneisses of Pre-Cambrian aspect.

North-West Miramichi River.

On the main North-West Miramichi, ashy, reddish and grey slates are first seen at the bridge at Chaplin's Island, about eight miles below the mouth of Portage River. These are similar in many respects to the ashy slates of the Tête à Gauche and the Nipisiguit. Their general dip is N. 50° W. $<$ 40–60°. Above Portage River the series of black and irony slates already described, associated with grey and green sandy beds, are met which extend up to about one mile above Stony brook, a small stream from the south. Indistinct traces of fossils, of no use, however, for determination, were observed among the greyer beds. The black slates of this stream are cut by frequent irregular veins of quartz, often rusty and containing at one or two points traces of copper, but in quantity not sufficient to be of economic value. A short distance above Stony Brook the rocks change their character, becoming

Copper.



GEOLOGICAL SURVEY, 1880.

From Photo. by R. W ELLS

UPPER END OF NARROWS N. W. MIRAMICHI RIVER, N.B.

dense, hard silico-felspathic, often gneissoid and probably belonging to an older series, over these the river flows in a deep gorge, forming some of the grandest natural scenery in the province. They are often much disturbed, and dip at high angles. At the mouth of the Mountain Brook they resemble in character the gneissoid felsites of the upper part of the Nipisiguit, and these, with green chloritic and gneissoid schist, extend up for about twelve miles, above which point slaty beds, green and grey occur, which may be the extension of the Cambro-Silurian, as developed above Nine-mile Brook, on the Nipisiguit. Probable pre-Cambrian ridge

Rocks similar in character were observed also on the Big Sevogle and the Little South-west Miramichi. On the latter stream, after passing the Carboniferous beds which occupy the lower portions of the river for some twelve miles, green and grey beds of the usual type, with rusty and irony black slates and harder quartzite bands, extend up to within three miles of the mouth of the north fork, at which point gneissoid, reddish and grey felsites are met, which have an entirely different strike from the overlying series under discussion; and these continue up stream to the contact with the red granite belt of the northern portion of the province. As before remarked, in such an entirely unsettled country the impossibility of following the boundaries of the different formations continuously renders the fixing of their limits very difficult. Much of the surface is densely wooded, over great areas the woods have been blown down and ravaged by fire, and by far the greater portion is entirely inaccessible. Exposures also along the stream are not continuous, and it is possible that among the rocks included in the so-called Cambro-Silurian system, areas of other and older rocks may exist. The highly metamorphic character of the rocks also occasions great difficulty in assigning precisely each group to its proper horizon; but it is believed, both on general stratigraphical and lithological evidence, that the distribution as herein described is, approximately at least, correct. The apparent uncomformability of the two great systems is, however, quite evident at a number of points, though in such a large and generally disturbed area the most diverse dips are met with in close proximity to each other. And it is only by taking a broad and comprehensive view of the whole area under discussion that any satisfactory results can be arrived at. Contact of Cambro-Silurian and pre-Cambrian on the Little South-West. Uncomformability of the two systems.

PRE-CAMBRIAN.

The area which we have included under this head is occupied largely by highly metamorphic rocks, many of which are very felspathic, and for the most part gneissic in structure. The well marked petrosiliceous

beds and breccias and the crystalline limestones of the southern part of the province seem to be entirely wanting. With the exception of the sub-crystalline limestone of the Tête à Gauche of Cambro-Silurian age, and the locally altered marbles of the Silurian, no rocks of this kind have been met with in the vast stretch of country between the main South-West Miramichi and the Nipisiguit Rivers. The most northern prolongation of the rocks of presumed Pre-Cambrian age is seen in the upper part of the Tête à Gauche River, and consists of highly talcose and chloritic schists and slates; unconformable to the overlying Cambro-Silurian, and resembling in character many of the schists of the Pre-Cambrian of Albert and King's counties, described in the Report of Progress, 1878-9. On the Nipisiguit these rocks are much more extensively exposed, extending from below the Indian Falls, about forty-seven miles from the mouth of the river, some sixteen miles or so above the mouth of the Portage Brook, which takes its rise near the head waters of the Upsalquitch. They form lofty hills, reaching an elevation of not far from 2,000 feet above the sea, and present prominent features in the landscape which seem to indicate the extension of this formation. With the exception of the bright red granite in the vicinity of Bathurst, no rocks of this kind are seen along the river, but on the lower part of the main south branch which joins the Nipisiguit at 60½ miles from its mouth, granites of red and grey color are seen, fine-grained and resembling in character many of the granites of the Laurentian areas of the province of Quebec.

Distribution of the Pre-Cambrian.

Granite.

Above Portage Brook, to the head of the river, the prevailing rock is a hard, dense, often porphyritic and generally reddish felsite, the peculiar color of which is well seen in the bald summits of many of the huge rounded hills that occupy both sides of the river for a long distance.

Felsites.

The typical rock of the Pre-Cambrian of this region is a greyish, felspathic gneiss, often with a reddish tinge on weathered surfaces, and frequently containing hornblende. These hornblende schists are common, and many of them are talcose. They are well displayed in the hills about Portage Brook and on the portage to Upsalquitch Lake. They are highly crystalline, the banding being well marked on weathered surfaces, and are much crumpled, generally at right angles to the planes of bedding. The general dip of the beds in this vicinity is N. 60° W. < 45°. Great masses of this rock weather very rusty from the presence of iron pyrites, and are cut by quartz veins which, however, are often very irregular and reticulate, on weathered surfaces, in all directions. Similar rocks form high hills about the Upsalquitch Lake associated with hornblende schists, which dip N. W. < 15–20°, and present the same minutely crumpled aspect. Below Portage Brook

Characteristic rock of the Pre-Cambrian.

exposures along the river are few, ledges of similar character appearing, however, at intervals. At Blue Ledge, two miles below the forks of the South Branch, greyish gneissoid rock composed principally of quartz and hornblende in layers appears to dip south-easterly at moderate angles. Two miles further down, at a sharp bend in the river, known as Devil's Elbow, ledges of similar rock extend along the north side of the river, and have a dip of S. 40° E. $<$ 40°. This rock also occurs a short distance up the South Branch, associated with fine, dense, greyish granite containing black mica. They are all similar to the ledges occurring on the Upsalquitch portage, and are doubtless parts of the same series; and from this to the Indian Falls are seen in frequent ledges along the river and on the slopes of the mountain ridges on both sides. A short distance above the Indian Falls several prominent hills, known as the Bald Mountains, are seen to be composed of almost similar rocks; the dip, however, changes to S. 10–20° W. $<$ 90. Upper part of the Nipisiguit River.

The country to the south of the Nipisiguit, between Indian Falls and the Main South Branch, is very high and broken. Lofty mountains from 1,500 to 2,000 feet above the sea, in many places covered with impassable blow-downs, in others burnt completely bare, extend as far as the eye can see to the southward, and form the country about the head waters of the North-West Miramichi. Along the South Branch itself granite is the prevailing rock, sometimes grey and fine-grained, but more frequently red and coarse, and resembling that seen in Charlotte county, described in preceding reports. The character of the country, however, is such that it is impossible to tell with accuracy whether this coarse, red granite forms a broad, continuous belt or is divided into several ridges. The South Branch, after passing the forks, seven miles from its mouth, in ascending the stream shews no ledges, while the sides of the mountains alongside are generally an impenetrable jungle of green woods. Frequent pieces of gneiss and schist, however, in the bed of the stream seem to indicate that belts of these rocks are associated with the granites, and that the latter occurs in two or more ridges, separated by metamorphic areas. Below the forks of the South Branch, however, the granite is mostly fine-grained and differs entirely in character from the other and coarse red variety. The finer varieties may therefore be classed with the gneisses and felsite schists of the Pre-Cambrian, with which they are apparently intimately related. Large areas of these felsite schists and felspathic gneisses occur on the south side of the Nipisiguit River, below the South Branch, and are well disclosed in the elevations known as Little Bald Mountains, where they dip apparently N. 10° E. $<$ 50°. An elevation one mile to the west having a reverse dip of S. 10° W. $<$ 45°, shewing that these old rocks are thrown into anticlines. South of this, on the Little South West Miramichi, the

Broken country to the south of the Nipisiguit.

Two kinds of granite.

Gneisses and schists of Little Bald Mountains.

reddish-grey felspathic gneisses are also well developed and dip N. 50° E., generally at low angles of 5–20°. They here apparently rest upon, or dip away from, greenish-grey, fine-grained gneiss and hornblende schist, with crystals of clear quartz occasionally disseminated, dipping N. E. < 5–7°. Many of these schists are crumpled or twisted in small folds. Quartzose rocks and mica schists with chloritic and felspathic bands also occur. Above this to the contact with the granite about two and half miles below the middle North Branch, a succession of schists and felspathic gneisses with occasional dykes of reddish granitoid rock and felsites with micaceous diorite are seen, the dip becoming reversed as we ascend the stream, to S. 50° W. 45°.

Little South-west Miramichi.

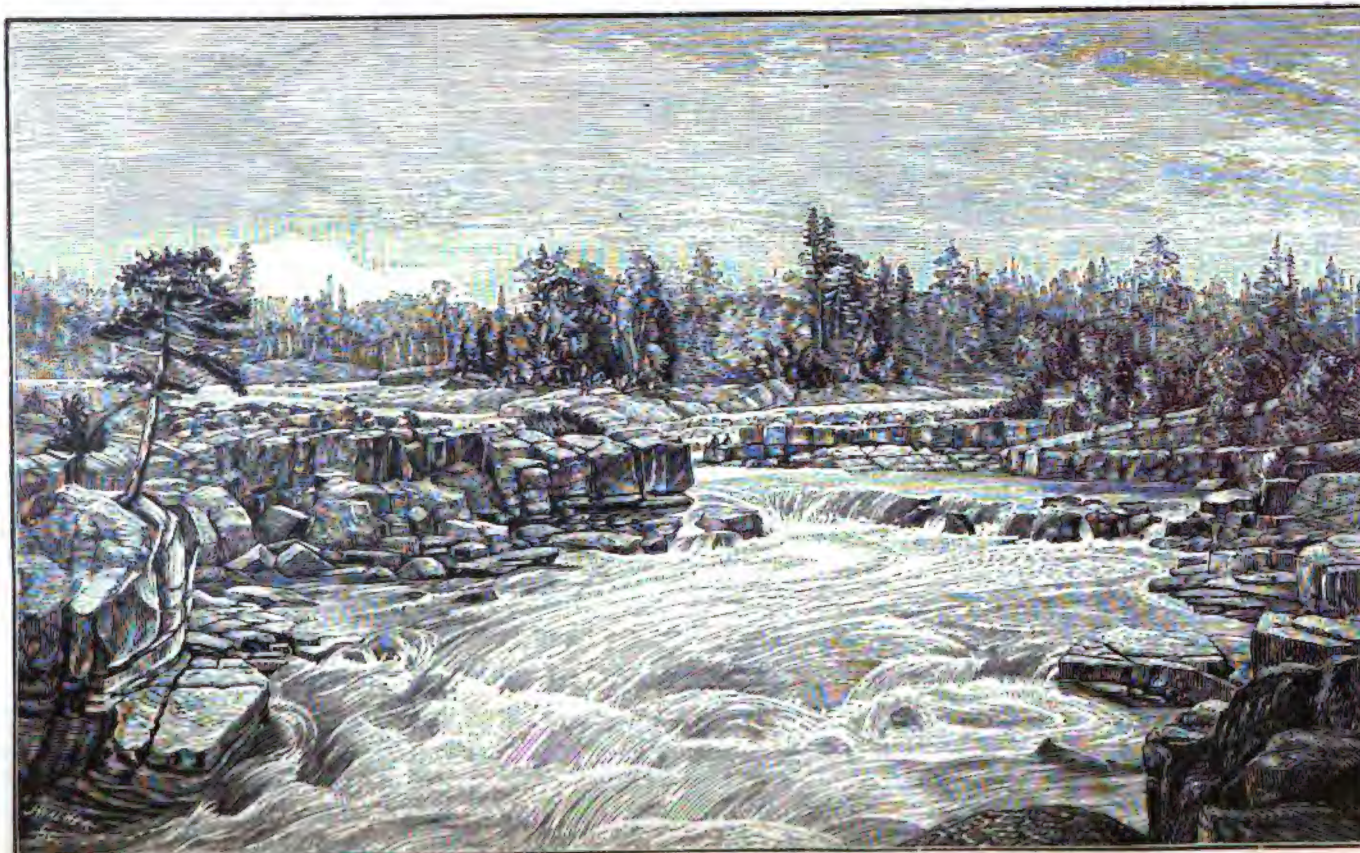
On the main South-west Miramichi, the rocks of this age seem to be confined principally to the gneisses of the upper part of the river or from a point about five miles below the forks. Other rocks along the river although schistose and gneissic seem to owe their metamorphism rather to local intrusions of red granite than to other causes, crystals of staurolite, etc., being developed in the beds along the line of contact with the granitic belt. The gneiss (pre-Cambrian) appears principally in low lying ledges in the bed of the river, and would be invisible unless in low stage of water. This area, however, owing to the difficulty of getting through the country was not fully examined, and further work in this section will be needed to fully establish the relations of the gneiss and mica schists to the granites and altered slates.

Main South-west Miramichi.

GRANITES, DIORITES, DOLERITES, FELSITES, &c.

Among the rocks generally regarded as of eruptive or irruptive origin, all of the above types are found. In the central area about the heads of the Nipisiguit and the North and South-west Miramichi, lofty peaks and continuous ranges of hills form the principal features of the landscape, and in these high lands the majority of the large streams flowing into the Bay Chaleur and the Miramichi take their rise. The general elevation of the lakes at the head of the Little South-west is, by aneroid, about 1200 feet above sea level. The granite here is exposed in low ledges along the stream, but further north about the head of the North-West Miramichi and south of the Nipisiguit branches, the country has a general elevation of about 1700 to 1800 feet. Isolated peaks like Big Bald Mountains rise above this to a further height of 630 feet, and long ridges of granite apparently extend south-westerly toward the main South-west Miramichi River. The typical granite of these mountains is the coarse red variety, similar to that of the southern part of the province in Charlotte county, having large crystals of red felspar, with quartz and mica, the mica being frequently

Character of country in interior.



GEOLOGICAL SURVEY, 1880.

PABINEAU FALLS, NIPISIGUIT RIVER N.B.

From Photo. by R. W. ELLS.

replaced by hornblende and these constitute the syenite of former reports, and occasionally both mica and hornblende are present.

In the vicinity of Bathurst, granites of this character are well exposed On the Nipisiguit they are first seen at the Rough Waters, three miles from Bathurst, where they form the bed of the river, overlaid by the soft red sandstones and fine conglomerates of the Lower Carboniferous. Thence they extend up stream for nearly nine miles, but do not shew on the south bank of the stream except at a very few points. They produce the rapids known as the Rough Waters, about three miles in length, and are well seen at the Pabineau Falls where the waters of the river have produced a rough and jagged chasm, forming a fall of great beauty. **Granite of the Nipisiguit.**

The granites are cut by dykes, generally of small size, of almost pure felspar (orthoclase), though sometimes they have the composition of syenite the felspar greatly predominating. In the upper part above the Pabineau Falls they are well jointed, and almost resemble bedded rock. They also become much finer grained than the ordinary variety seen in the vicinity of the railroad bridge. These granites are also seen on the Little and Middle Rivers for a short distance above the railroad crossing, and the lower part of these streams is choked with huge blocks of this rock. Low ledges also appear on the line of the railway between Bathurst station and the Nipisiguit River, wherever the covering of drift has been removed.

On the main South Branch of the Nipisiguit the granites probably have their largest development in this portion of the province. This stream joins the Nipisiguit from the south at about sixty miles from Bathurst, and flows through a granitic country for the greater part of its length. Ascending, we first strike granitic and dioritic rocks at about half a mile from its mouth. This rock is mostly grey, composed of quartz, felspar (grey), and often black mica, though frequently the felspar is red and gives its color to large areas of the granite. It is, however, fine-grained, and entirely unlike the common red granite of Bathurst and the interior range of mountains at the head of this stream. This fine-grained variety extends up the South Branch about five miles, to within one and a half miles of the Fork, the red color predominating as we ascend the stream. In places it resembles very closely the fine red Laurentian granite in the vicinity of Kingston. No gneiss or mica schist is seen with this rock. It forms immense mountains, whose white weathering bald sides, often terminating in vertical bluffs of several hundreds of feet, flanked by huge heaps of debris, present prominent features in the landscape. The scenery is among the grandest in the province. Huge hills extend as far as the eye can reach. These are often burnt completely bare and **Character of the granite on the South Branch.**

the mountain rock is entirely denuded of soil; at others small clumps of green woods break the sterile aspect of the country and indicate the course of some small stream. Thousands of acres of timber have been completely destroyed in this portion of the country, and the soil in many cases so completely burnt off that only a small growth of bushes can now find footing. These hills in the fall of the year are fairly blue with blueberries and abound with bears. The streams are for the most part, especially when a young growth has sprung up, well stocked with beaver, which, in spite of their wholesale destruction, are still plentiful in nearly all the streams of the interior.

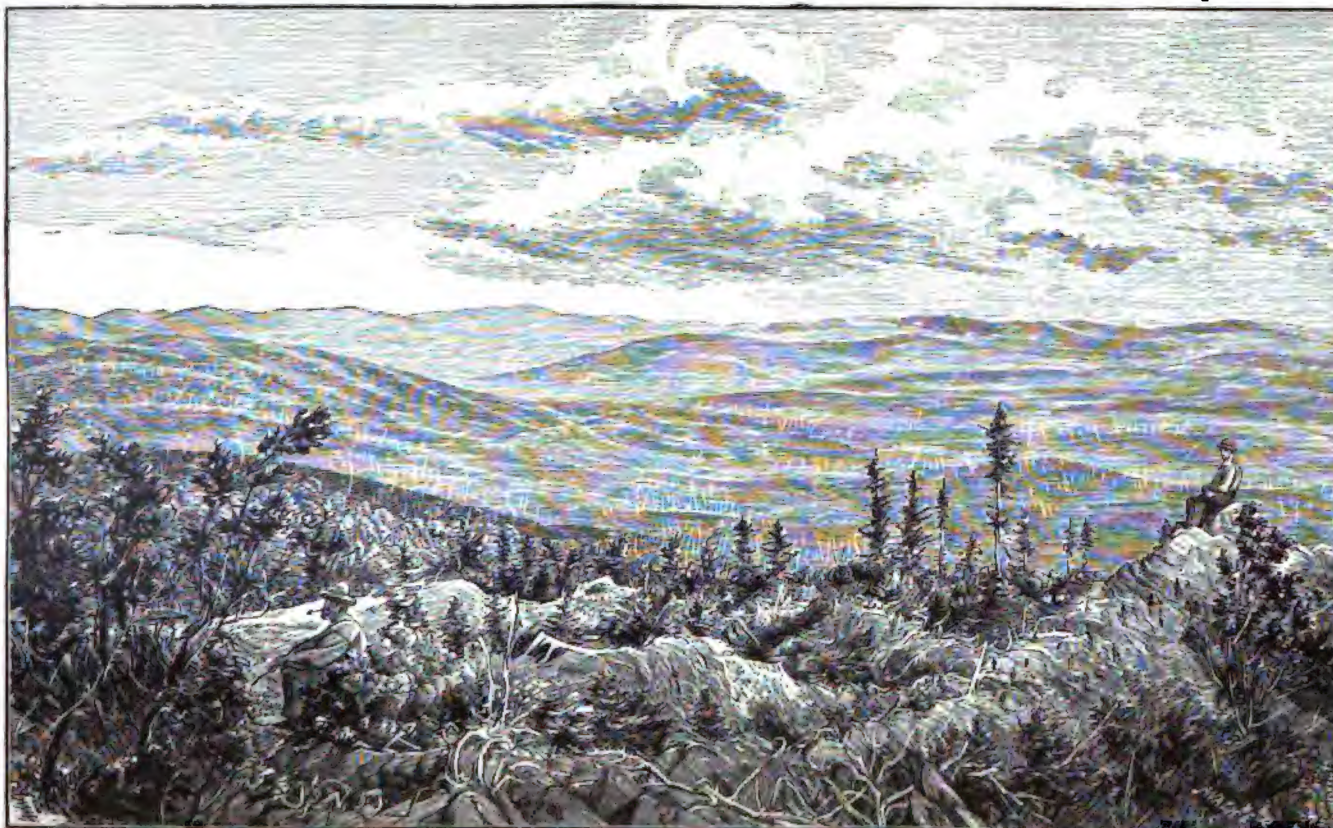
Burned country.

About one and a half miles below the fork of the South Branch, or six miles from its mouth, the fine-grained red granite suddenly changes to the ordinary coarse red variety. This is well exposed up to the Forks, above which the stream for some fourteen miles flows through a low and swampy hollow between high mountain ranges densely wooded and almost impassable. It is difficult, therefore, without further examination of some of the side branches to say definitely whether the granite forms a continuous belt from this point to the Big Bald Mountains near the head of the stream. It would, however, almost appear, from the quantity of schistose and gneissoid pieces brought down by some of the small branches from the east side, that the granite may occur in parallel ridges with areas of mica schists, gneisses, etc., intervening. This view is also supported by the strike of the gneissoid beds which flank the eastern extremity of the granite area. From the observations we have been able to make in the country south of the Nipisiguit, or between that river and the main South-west Miramichi, it seems probable that there exist at least two and probably three main granitic axes, which extend North-eastwards from the Miramichi. The continuation of these granitic hills has been traced further west by Mr. Charles Robb, who has defined two of them east of the St. John River between Fredericton and Woodstock. On the main South-west Miramichi, however, other minor axes of granite are seen, in places separated by only a few yards of slaty or schistose rock. It is probable that several of these smaller bands merge into one, as they extend east or west from the river. Of these, the most southerly belt is that seen in the Little South-west Miramichi, where it first appears about two and a half to three miles below the Middle North Branch, extending north-east from the river about four miles, but terminating before it reaches the main North Branch. From its first contact with the Little South-west it extends up the river several miles, or to near the outlet of the Little South-west Lake, where ledges of mica schist and other rocks again come in. This belt is first seen on the main South-west, a short distance below Stony Brook, whence it ex-

Probable distribution of the granite on the South Branch.

Several granite belts.

Little South-west.



GEOLOGICAL SURVEY, 1890.

BALD MOUNTAIN, LOOKING UP NIPISIGUIT RIVER, N.B.

From Photo. by R. W. ELLS.

tends up stream for several miles, or to about one mile above Clearwater stream, having, however, in this distance a small band of hard grayish quartzose rock or slates which are probably of Cambro-Silurian age. The second main granite area on the main South-west begins just below McDonald's Brook and extends along the river to within about five miles of the Forks, with a direct breadth of a little more than six miles. Tracing this belt north-eastward it is found to constitute the high ridge between the waters of the Tobique and the Little South-west Miramichi, crossing the head-waters of the north branch of the latter stream, whence it continues north-eastward and crossing the head waters of the south branch of the Nipisiguit, rises into the bold elevations known as the Big Bald Mountains, with a height of about 2,500 feet, whence it stretches to the headwaters of the North-west Miramichi, where it terminates. The third and most northerly belt noticed by us is seen on the north-east of the main South-west Branch, above the Forks, where it appears as low lying ledges in the bed of the stream at intervals for some fifteen miles. The eastward extension of this belt has not yet been traced, but it probably is the same as is seen about the Tobique and Long Lakes, at the head of the Right-hand Branch of the Tobique River, and on the South Branch of the Nipisiguit in the vicinity of the Forks already described. None of these belts apparently cross the Nipisiguit, the area about Bathurst being the only one of the kind seen on that river or to the eastward of it.

Main South-west Miramichi

Extension of the different belts.

The granites of the South-west Miramichi, though generally red in color, are occasionally grey, the mica is often black and the felspar is frequently in large crystals. The contact of the granites with the slates is well marked along this river. In places, crystals of staurolite are developed in the slate along the junction; at others the granite seems to lose its red color and becomes white, almost a pure felspar, the hard slates in contact are altered to a hard schist and crystals of mica are developed in cross viens in them near the junction. The purple slates and quartzites are also filled with crystals of iron-pyrites; and at other points the slates near the line of contact appear broken and confused for several yards from the granite, as though heavy disturbances of the strata in that vicinity had occurred. Further explorations, however, are desirable to establish the connection of the granite areas between the Tobique waters and the Nipisiguit as well as to more fully determine the relations of the granites to the mica schists in that area, but it is to be feared from the generally densely wooded character of the country that accurate tracing of boundaries will be an impossibility.

Contact of granite and slates.

Felsites—These are largely developed along the upper portion of the Nipisiguit River, as well as around the southern side of the Nictor Lake,

or head of the Little Tobique River. On the south side of this lake a huge mountain rises to a height of about 2,500 feet, flanked on its north side along the shore of the lake, by green talcose and chloritic schists, of Pre-Cambrian aspect. This high mountain is composed of hard, dark red crystalline felsite, porphyritic, with crystals of red felspar, and stretches off in a long ridge towards the south-west, or to the right-hand branch of the Tobique. It probably forms a continuous ridge to the Forks of that stream, as rocks somewhat similar in character appear at that point. The hills fall abruptly towards the east, or across the portage between the Tobique and Nipisiguit waters, but rise again to the eastward, and continue towards the south-east branch of the Upsalquitch River. This portage shews no ledges, but large blocks of the crystalline felsite lie scattered about, along with pieces of the schist. The Upper Lake or head of the Nipisiguit is enclosed by lofty hills, which are broken at the outlet. Descending the stream, ledges are not very numerous for several miles, but where seen consist of dark, red or purple tinted felsite often brecciated, and large angular blocks of the same are frequent. Just below the Little South Branch is a high mountain, composed apparently of dense banded, light red felsite, with abundance of iron pyrites along the joints. These are cut by dykes of fine, very hard, diorite, greyish in color, the felsites being porphyritic, like that of the Nictor Lake, and generally breaking into sharp, square blocks. Three miles below the Little South Branch, or at the 68-mile tree, ledges of the same banded rock occur, which seem from the banding to dip S. E. $< 20°$. Two miles lower down a huge dome of felsite, with bald sides and top, forms a conspicuous object, its bright, red color being distinguishable for a long distance. Thence down, to within a short distance of the Portage Brook, where the portage to the Upsalquitch River strikes across, these rocks continue till they are met by the schistose or gneissic rocks already described under the heading Pre-Cambrian.

Felsites of the Upper Nipisiguit.

The scenery along this portion of the Nipisiguit is very fine. The felsite hills occur in a succession of peaks often rounded or dome-shaped, which stretch along both sides of the river, and the view from any of them shews the surface of the country to be a sea of mountains in all directions. In character, the rock resembles much of the old Pre-Cambrian felsites of the southern portion of King's and St. John counties both in the occurrence of breccias, petrosilex and its general porphyritic and highly crystalline nature. It would appear, from comparison with other rocks elsewhere, to be the equivalent of the felsite series of the southern portion of the province, and therefore to be a part of the mica schist and gneiss series, probably a lower portion of it.

Character and probable age.

Below the Portage Brook, on the Nipisiguit, but few pure felsites are

seen; where they occur the exposures are limited, and of the nature of dykes; but on the Upsalquitch a large area of these rocks is again met with, which is probably the eastward extension of the main felsite belt from the upper part of the Nipisiguit. Just below the Upsalquitch Lake, however, several exposures of diorites, gabbros and mottled felspathic rocks occur, apparently intervening between the gneissoid rocks of this region and the Silurian, already described as occurring in this river. Just below Meadow Brook, a small branch of the Upsalquitch from the east, the typical hard, red crystalline felsites again appear, the extension as mentioned of the felsite rocks above described, and are associated with hard, green epidotic rocks. The felsite belt has been traced eastward almost to the shore of Bay Chaleur, and forms a ridge along the north side of the Jacquet River, rising into considerable elevations at several points, though in none possessing the marked prominence of the hills in the interior. They are flanked along the Jacquet River by Silurian beds, often fossiliferous, and the beds of brown, red conglomerates, mentioned in the vicinity of New Mills, as well as at other points along the coast in that vicinity, have probably been largely derived from the debris of these felsites, as the pebbles composing the conglomerates are nearly all of this character.

Gabbro.

Felsite belt of the Upsalquitch and Jacquet Rivers.

Descending the Upsalquitch, no other exposures of any size are met with. A high, red mountain of felsites occurs about three miles above the forks of this stream, and ledges of the same occur along the river at this point, but the area is probably detached and but of small extent.

Below the forks of the Upsalquitch, several dykes of felsite are seen cutting the Silurian slates; these are, however, quite distinct in character and mode of occurence from the great felsite areas already described. They are, from their position, subsequent to the Silurian beds, and probably of the same age as the trappean ridges of Dalhousie and the lower part of Restigouche, as felsite areas of small size occur among the trappean rocks as an integral portion.

Felsite dykes.

Dolerites.—These rocks are extensively developed about the lower portion of the Restigouche from a point four miles below the mouth of the Metapedia River to Dalhousie, and also at intervals along the coast southward almost to Bathurst. They are of varied character; sometimes dense, dark green, hornblendic traps, frequently amygdaloidal, and at other times brecciated, and frequently resemble the Triassic traps of Nova Scotia. Their age, however, is pretty well determined. At many points they are seen in the form of dykes cutting through fossiliferous Silurian rocks, and changing the character of the slates in contact to hard quartzites or porcellanizing them, while the fossiliferous limestones are sometimes converted to a crystalline marble, in which, however, the fossiliferous nature is clearly distinguishable. On the

Distribution and character of the dolerites.

Their age.

other hand, they do not alter the Lower Carboniferous beds, which frequently are superimposed directly upon them, nor the Devonian rocks of the lower part of the Restigouche, and pebbles of the trap are frequent in the latter. Further, the Devonian beds of this locality seem to have been deposited after the trappean hills had received their present outlines, as they can be seen to sweep around the base of the trap hills, and to conform in strike with their irregularities. At one or two points, however, small dykes of trap of subsequent date to the main body of the rock are seen penetrating the Devonian beds as at Point la Lime, where a dyke forms a roof for a bed of carbonaceous shale. The contact of the trap or doleritic rocks with the Silurian and their relations can be well studied at the point below Dalhousie. The intrusions here seem to have been injected along the bedding planes of the slates and limestones, and at first glance would appear to be an integral part of the Silurian system. Examination, however, shows the limestones and slates to be highly altered to a distance of several feet from the contact, while in one place the trap has caught and inclosed in its mass a small portion of Silurian fossiliferous limestone. At Dalhousie it occurs along the shore in a number of ridges, five distinct ones being counted along the road from Dalhousie down to the Eel River flat, about two miles by the road. These ridges are in every case separated by lenticular areas of highly fossiliferous Silurian rocks, which, however, do not apparently extend westward from the shore more than a couple of miles.

Minor dykes in he Devonian.

On the road leading west from Dalhousie towards Campbellton the doleritic rocks present many of the characters of stratified beds. They lie in broad sheets like freestones, dipping N. 40° W. $<$ 35°, but on examination are found to be compact, highly crystalline rocks. They have here been extensively quarried for the construction of railroad bridges; and they occur in a similar manner alongside the post road to Campbellton, about four miles west of Dalhousie station, but the rock at this point is brecciated. The general extension of the trappean ridge along the south side of the Restigouche may be said to be from Dalhousie westward to the Glenlivet road, about ten miles west of Campbellton. A break, however, occurs near Dalhousie station, where a depression, partly filled with Devonian and Lower Carboniferous sediments, affords a passage for the Intercolonial railroad from the flats of Eel River to the waters of the Restigouche. The breadth of the trap ridge, west of Dalhousie station, is about three miles, with elevations of 1,000 to 1,200 feet in height. Its southern limit is just at the most southerly of the two roads through the settlement of Dundee, whence Silurian slates extend southwards. Trappean ridges of undefined extent, however, occur, associated with the Silurian rocks along the Eel River, but the

Bedded structure of the dolerite.

impassable nature of the country prevents the tracing out of the different belts.

At Campbellton a conspicuous mountain, called the Sugar Loaf, rises abruptly about one mile south of the station to a height by aneroid, of 1,000 feet above the river. The mountain consists of hard, reddish, grey crystalline felsite, resembling much of that in the southern part of the province, weathering a dirty reddish grey. No trappean rocks were seen in this peak, which rises like a huge wedge-shaped cone from the felspathic ashy rocks around its base. The mountain is narrow, its crest being only a few feet in width, but elongated, with steep, nearly perpendicular sides for several hundred feet from the top, and a long, gentle slope at the eastern end, the western extremity being much more abrupt. The direction of the crest is about ten degrees north of west magnetic. A magnificent view is obtained from its summit, not only of the Restigouche from below Metapedia and far down the Bay Chaleur, but also of the surrounding country to the north and south. High ranges of hills can be seen rising on the Quebec side for a long distance inland, while to the south the view is interrupted by a high ridge of trappean rocks. To the west a succession of rounded peaks of felsite and trap extends as far as one can see, while the pretty town of Campbellton lies spread out at its base. The volcanic character of many of these hills is apparent both from the nature of the rock constituting them and from their peculiar cone-like shapes. This is especially noticeable in some of the peaks on the north side of the Restigouche and about the Scaumenac River, where side cones often exist, jutting up from the otherwise sloping sides of the mountains. In the Sugar Loaf at Campbellton one can almost detect a dipping of the felsites from both extremities of the mountain towards the centre.

Sugar Loaf Mountain.

On the Upsalquitch River a large area of trappean rocks is seen about seven miles above the forks, with a breadth along the river in a direct line of about three miles. They are frequently very amygdaloidal, and contain amethysts and agates, with heulandite and other zeolites. Zeolites and amethysts of considerable beauty are also found among the trap rocks in the vicinity of Dalhousie.

Trappean belt in the Upsalquitch.

Along the coast, between Dalhousie and Bathurst, frequent exposures of doleritic rocks are seen, some of which have already been alluded to. Many of these are of but small size and are well defined dykes, while others are of considerable extent, having a breadth of several miles. The most important of these occur along the line of the Intercolonial, between the Tête à Gauche River, north of Bathurst and Belledune station. A very good cross-section of these rocks, shewing their varying character, is seen on the road running almost north from Peter's River, about one mile north of the Tête à Gauche to Dunlop settle-

Section north of Peter's River.

ment. At the road crossing Peter's River is a moderately high hill or low ridge of dark, greenish-grey trap, moderately fine-grained, and amygdaloidal in places, with small zeolites and thin veins of red hematite, already alluded to, associated with veins of bright red jasper. Ascending from the river, the following traverse over these rocks was made:—

	PACES.
Ascent over ridge mentioned above	512
Purplish or dark grey trap	297
Dark greenish trap, mottled with light green and slightly porphyritic in places, in others amygdaloidal, with calcite, giving the rock a scoriaceous aspect on weathered surfaces	85
Dark flesh-red felsite, highly crystalline, and cut by dykes of dark fine-grained diorite, rock rubbly	217
Dark grey felsite breccia, the brecciated pieces being in size from half an inch to one foot	77
Purple ash-rock, filled with small crystals of calcspar	300
Dark greyish ash-rock conglomerate	130
Purple and reddish-grey felspathic breccia, very rubbly and weathering a reddish grey	15
Dark green fine diorite, with small specks of yellowish green epidote.	21
Brecciated conglomerate, pebbles, nearly up to a foot in size of flesh-red felsite, sometimes porphyritic, and with a scoriaceous look on weathered surfaces from the presence of small amygdules of calcite probably. This may be the concretionary rock described as occurring along the line of the railway	210
Hard greenish-grey, highly crystalline diorite, moderately coarse	137
Very scoriaceous purple grey trap, with calcite and small veins of red hematitic, rock often very ashy in texture	166
Purple ash-rocks, apparently schistose in places or a schistose conglomerate, containing pebbles of red hematite and purple ash-rock, with an apparent dip of S. 20° E. $< 75°$	118
Green schistose rock, a conglomerate in places, in others rubbly and rusty, to cross roads in Dunlop settlement	770

Several cuttings in these rocks are visible along the railroad, and the concretionary and scoriaceous character of some of the beds is well seen.

These rocks are associated with the so-called Cambro-Silurian group already described. As they are not in contact with Silurian rocks, their relative ages cannot be determined so well as in the case of the trappean beds farther north, but it is very probable, from the similarity of composition and general character, that they are contemporaneous.

Doleritic rock of Elm Tree River and vicinity.

The second area of doleritic rocks of large extent begins near the railroad bridge over the Elm Tree River, and is well seen in the various cuttings and snow sheds for several miles, or nearly to Belledune station. In the sheds at the Elm Tree River the rock is hard, com-

pact and greenish, with minute reticulating veins of white calcite and some quartz, and contains pyrites in small specks. As exposed in the sheds at this point the breadth of the dyke is 1,000 paces, and contains at one point a thin band of soft red slate. At the contact with these the wall of the dyke is well defined, and the slates appear to have been altered for an inch or two into a shaly, greenish, talcose-looking rock, though the rest of the bed does not seem to have been greatly affected. An interesting secondary dyke, from five to eight inches thick, is seen cutting the main belt of irruptive rock. Thence for a distance of about five miles along the railroad similar greenish dioritic or doleritic rocks are seen at intervals. In places these have the same concretionary structure as noted in the traverse above; frequently they are epidotic and chloritic, and contain a good deal of calcareous matter disseminated. At several points these bands of reddish or blackish slates and hard conglomerate, some of which appear to be altered by contact, are observed, but the area occupied by such rocks is very limited.

Between Belledune Point and Jacquet River several dykes of dolerite, generally amygdaloidal, though occasionally crystalline, are seen. These are, for the most part, small, and never more than a very few yards in extent. They are seen cutting the Silurian rocks, but not affecting the Lower Carboniferous beds, which cap them unconformably, and the trap pebbles often enter largely into the composition of the basal conglomerate of the latter. Beautiful sections are afforded along this shore of the Silurian, the Lower Carboniferous and the trappean rocks, and the relations of the three are very nicely defined. At Black Point, however, nearly opposite the lower end of Heron Island, the dolerite appears again in considerable force, cutting as usual through Silurian beds, and being intimately associated with the hard, dark brown conglomerates of this part of the coast. At Beaver Point also, about one mile further north, they again appear, and have a breadth of several miles; or to the mouth of New Mills Brook, where they are met by the heavy dark brown conglomerates in force. Other and larger areas also occur south of Charlo River, associated with fossiliferous calcareous beds. The western extension of these various bands of eruptive rocks has not been traced. The settlements in this part of the province are confined to a strip along the coast of scarcely more than a mile in width, and in the dense and swampy lowlands or the rough and hilly wooded portions further back, progress is almost impossible. They do not, however, extend probably to any very great distance, as they are not seen on the Upsalquitch, but may possibly assume the aspect of lenticular areas of greater or less extent, which have burst through probably at the close of the Silurian. Slices of these rocks will be prepared for examination under

North of Jacquet River.

Charlo and vicinity.

the microscope, and be reported on. They seem to be very similar in character, and probably do not differ much in age.

North side of the Lower Restigouche.

On the north side of the Restigouche, in the province of Quebec, the western limit of the trappean ridges has been fixed. It is directly opposite the limit of the trap, on the south side of the river, but the northern limits and its extension eastward have not yet been determined. It is, however, evident that the valley of the Restigouche was clearly defined at this period, as the Devonian beds now occupy its basin, and the doleritic rocks probably extended then as now in two lofty and tolerably regular ridges along its two sides. Evidently no disturbance of any importance has occurred in this vicinity since the deposition of the Devonian fish-bearing beds, as in nearly every case they lie nearly in a horizontal attitude or inclined at low angles, forming a shallow, synclinal trough between the two ranges of hills, and occupying the beds of the river and harbor between Campbellton and Dalhousie.

Surface Geology.

In the report of Dr. Gesner to the New Brunswick Government (1843) the surface deposits of the coast between Bathurst and the Restigouche are well described. They are there divided into the "Upper and Lower Tertiary." In the former he includes the white marls, and in the latter the grey, blue and brown clays containing marine shells.

Shell marl.

Of the former, or white marls, several deposits of considerable value exist. One of these is near Belledune Point, the thickness of which is about two feet, overlaid by some five feet of peaty soil. It is nearly a pure carbonate of lime, with several species of fresh water shells. A second deposit occurs in a road leading back from the shore about two miles north of Charlo station, where it is seen occupying the bed of a small lake or overflow of a brook, the character being similar to that just described. These marls are used locally to a slight extent, but the abundance of lime in the soil from the decomposition of the Silurian calcareous slates and limestones obviates the necessity for its application in any considerable quantity.

Marine clays.

Along the line of railway north of Bathurst frequent cuttings are observed in the grey and blueish-grey Post Tertiary marine clays. The first of these is seen a few rods north of Bathurst station, where dark brown-red clays, overlaid by several feet of gravel, contain abundance of shells of *Mya arenaria* and *truncata*, *Tellina Grœnlandica* *Astarte Laurentina*, *Saxicava rugosa*, a Natica and a Venus (Mercenaria). A larger cutting is seen just above the Tête à Gauche bridge. Here the overlying gravel, generally fine, has a thickness of about fifteen feet,

the clay also has about the same thickness, and shells of the same species are seen in abundance in the latter. The height of this cutting above the sea level is about eighty feet. Other cuttings of considerable extent are seen on the railroad in the vicinity of Jacquet River, as well as between this locality and the Eel River; and at the forks of this stream, in Shannonvale settlement, the clays occupy large areas, with a thickness of ten to fifteen feet, often covered by a thick stratum of sand and gravel.

At several points along the Upsalquitch and Restigouche, terraces of considerable extent are observed and have been already alluded to. On the former stream four very perfect ones are seen on the west bank. At the Chain of Rocks Brook, on the Restigouche, about eight miles above the Upsalquitch, three perfect and one irregular one were noticed, and at the forks of the Kedgewick two well-defined are seen. The general height of these terraces is about ten feet.

Peat bogs exist in large areas in the eastern part of Gloucester and Northumberland counties, especially near the shore of the Gulf of St. Lawrence. At Point Escuminac and on the south side of the Miramichi harbor they have a depth in places of over thirty feet. They are also found in the vicinity of Shippegan and in the Island of Miscou. Quantities of walrus and other bones are found on this Island at a considerable distance from the shore. **Peat bogs.**

Striæ or ice-grooves were observed at several points; on the Peter's River, north of Bathurst, they have a nearly east and west course (N. 85° E.), as also in the vicinity of the Elm Tree River, but the great thickness and wide extent of the superficial drift renders the exposures of striæ rare. **Glacial markings.**

Economic Geology.

Although in the area examined during the past two seasons minerals in considerable variety were observed, some of which have been mined quite extensively in former years, the greater part appear to exist in quantities so small and under conditions so unfavorable that the prospects for their successful development are not promising. They were, however, carefully sought for, and a brief description is herewith appended.

Gold.—The occurrence of gold has been reported from a number of localities. Professor Hind, in his report to the New Brunswick Government (1865), mentions the discovery of gold in small quantity at several points in the Nipisiguit in the drift, but in no case did the washings indicate its existence in paying quantity. Quartz veins are very numerous throughout the whole extent of the metamorphic rocks, many of which were broken up and carefully examined, **Gold in the drift.**

but no visible gold was observed in any of them. The great majority of these veins are small and irregular, and often of the nature of short, gash veins. Washings at various points frequently disclosed the existence of black sand, with which the gold is often associated, but gold was not found, though many persons have been deceived by the occurrence of small scales of yellow mica and minute particles of yellow pyrites. Explorations have been carried on irregularly by various persons for a number of years, apparently without any satisfactory results. A company, during the summer of 1879, however, profess to have found quartz in one of the branches of the Nipisiguit that yielded gold at the rate of $5.00 per ton. This company subsequently carried on operations on the Millstream, about eight or ten miles from Bathurst, in rocks of presumed Cambro-Silurian age, the result of which has not yet been learned. On some of the streams in the county of Northumberland good specimens of gold-bearing quartz are reported to have been picked up several years ago, and the number and aspect of the quartz veins at several points renders the occurrence of this metal probable. On the Little South-west Miramichi a fine specimen of gold is said to have been found, about three miles above the North Branch, and not far below a heavy rapid known as Main's Ledges, while on the Main South-west several small pieces have been obtained a few miles above Boiestown, but the exact locality from which these were originally derived, has not as yet been ascertained. Mispickel and other forms of pyrites occur in considerable quantities in these rocks, and in places the quartz veins look promising. A few specimens were examined in the laboratory of the survey, but without affording any trace of gold. It seems probable that, if it occurred in any considerable quantity, the various explorations would have revealed some trace of its existence. The equivalents of the gold-bearing slates of Nova Scotia have not been discerned in this portion of the province, and though from the large area which has not yet been examined, owing to the difficulty of access, further explorations may be more successful, the conditions do not seem to warrant the expenditure, in so far as seen, of any very considerable amount of capital in that direction.

Barren quartz veins.

Mispickel.

Copper occurs in very limited quantity at several points and in different formations. The deposit formerly worked at Bathurst, in the Lower Carboniferous rocks, has been already described under that formation. Other localities where mining has been carried on are the Falls of the Tête à Gauche and the Baldwin Mine, on the Nipisiguit, about twelve miles from its mouth. In both these localities the amount of copper was very small, and the results exceedingly unsatisfactory. The extension of the belt in which the Baldwin Mine is situated can

Copper mines of the Nipisiguit and Tête à Gauche.

be readily seen on the North-west Miramichi and in the Big Sevogle further south, and at both these places copper pyrites and red oxide or cuprite was seen in small quantity, and the indications are quite as favorable in one locality as the other. None of them, however, contain sufficient copper ore to warrant any expenditure of money, and do not equal in value many of those seen at various points along the coast of the Bay of Fundy.

Manganese was formerly mined at the Tête à Gauche Falls. Its mode of occurrence in the Cambro-Silurian red and black slates in the form of small nodules has been already described. The slates were crushed in a stamp mill, and the ore separated by washing. No large deposits similar to those of the southern part of the province were found, the Lower Carboniferous limestones and conglomerates, in which they usually occur, being wanting in this part of the country. Many of the rocks of the Cambro-Silurian are deeply stained from the presence of this mineral, but no well-defined veins have anywhere been seen. The company which worked the mine at the Tête à Gauche are reported to have extracted a large quantity of the ore, but the results were evidently unsatisfactory, as the works have long since been abandoned.

Manganese of Tête à Gauche.

Galena, said to be rich in silver, has been reported as occurring in detached masses of considerable size at several points along the Nipisiguit; no deposit of it has ever been seen on this stream, but traces of it were found by us in some of the rocks in the area under examination. Such rumors are frequent in various parts of the province, and but small reliance can be placed upon them. It is possible, however, that in connection with the graphitic and sub-crystalline limestone bands seen on the Tête à Gauche, and which probably cross the heads of the Nine-mile brook, a tributary of the Nipisiguit, as well as on the head waters of the Millstream, and the streams in that vicinity, deposits of this mineral may occur, but as those localities are accessible only with great difficulty or on snowshoes, the discovery of such, if ever made, will doubtless be due to accident. On the Nigadoo, however, near the contact with the Silurian rocks, indications of galena were noted, and at the Forks of this stream, about eight miles from its mouth, a deposit of considerable extent occurs, which bids fair to be of some importance. Since our visit to this place in 1879, mining operations have been commenced, the samples of the ore obtained being of good quality, but the extent of the vein has not yet been fully determined.

Galena reported on the Nipisiguit.

Galena (Argentiferous) of the Nigadoo River.

Molybdenite has been known to exist in small quantity in the quartz veins cutting the schistose rocks at the mouth of Burnt Hill brook, a tributary of the main South-West Miramichi, and has been alluded to

in the report of Mr. Chas. Robb (1869) on that region. It cannot be said to possess any economic value, as the amount is very limited.

Gypsum of the Tobique.

Gypsum or Plaster is not known to exist in the area bordering on the Gulf of St. Lawrence. The only deposit of the kind in the northern portion of the province is found on the Tobique River, near the mouth of the Wapskehegan, in rocks of Lower Carboniferous age. This has already been described in previous reports by Messrs. Hind, Gesner and Robb. Within the last few years a considerable demand has sprung up for it in the vicinity of the Upper St. John, and a mill for grinding it for agricultural purposes has lately been erected on the Tobique.

Coal.

Clifton.

Coal is known to occur at various points throughout the great extent of the Carboniferous system in eastern New Brunswick. At Clifton, sixteen miles below Bathurst, a small seam of a few inches only is seen in the cliffs, and underlies the grindstone quarry at this place. It is stated by Mr. Read, owner of the quarries, to have a total thickness in places of eighteen inches, but the greater portion of this is black carbonaceous slate, and the hard or coaly portion does not exceed six to eight inches. Coal of considerable thickness is also reported from the Island of Shippegan, at Pigeon Hill, but owing to the lateness of the season when visited and the unwillingness of the owners of the land to disclose its outcrop, nothing definite could be learned of its extent. Samples of the coal, however, seem to be of very good quality, and if a workable bed could be found in this locality it would be of great value from the convenience of shipping. It would be an easy matter to test this place by boring, and the prospects are such as to warrant a moderate outlay in solving the question of its occurrence.

Shippegan Island.

South-west Miramichi.

Probable extension of the Grand Lake bed

Thin seams also are found in the vicinity of the South-West Miramichi and between this river and Shediac, but these outcrops have not yet been carefully examined. They may be, and probably are, on the extension of the seam which has been worked at Grand Lake, and if so, would show that the formation, as developed in this province, is very thin. The judicious expenditure of a few hundred dollars would prove the point, and determine whether, as the coal fields approach the productive measures of Nova Scotia, thicker and more profitable seams may not occur. The measures lie in such a horizontal attitude that superficial examinations do not yield much information on this point.

Grindstones.

Grindstones and *building stones* of excellent qualities are found at various places throughout the Carboniferous area. The former are extensively quarried at Clifton, about sixteen to eighteen miles below Bathurst, whence they are exported largely to the upper provinces and to the United States. Grindstone quarries are also worked at several localities on the North-West Miramichi, as well as below the town of Newcastle. Building stone has been quarried for local purposes in the vicinity of

Tracadie, in the eastern part of Gloucester county, and the fine Roman Catholic churches of Caraquet and Tracadie, as well as several other fine buildings, were constructed from stone obtained in their vicinity. Many of the beds are quite free from pyrites, and are equal in quality to the fine stone obtained in the south-eastern part of the province.

Limestone occurs throughout the greater part of the Silurian system. It is especially abundant in the vicinity of Elm Tree River and Belledune, and is quarried to some extent for burning. The local demand, however, is not great, and the distance from a profitable market such as to interfere with its regular production. The marble in the vicinity of Petite Roche and Elm Tree would be a valuable stone were it not so shattered, probably by the intrusion of the trap dykes of this locality. It is, however, frequently burned for lime. The alteration of the limestone to marble is only local, and the deposits are not likely to prove of value, save for calcination. The ordinary limestone of this vicinity was extensively quarried, and used in the building of the bridges along the line of the Intercolonial railway. **Limestone.**

Granites.—The rock in the vicinity of Bathurst is of equally good quality, with much of that in the southern portion of the province as a building stone, and has been largely employed in the construction of many of the immense bridges along the line of the Intercolonial railway. Several quarries have been opened in the vicinity of the Nipisiguit River, but except for use on the railroad, no attempt has been made to work them. The expense of shipment is against its successful working as compared with the quarries on the St. John River and in Charlotte county. A limited out-crop of this rock occurs on the Benjamin River about four miles from its mouth, and has been locally used for mill-stones. **Granites.**

Slates.—Some of the bands of slate along the lower part of the Tête à Gauche River seem to be fairly adapted for the manufacture of roofing slates, but the expense of opening quarries would be great, and the demand so limited that their economic value may be considered as small. **Slates.**

Peat.—The extensive beds of peat in the vicinity of Point Escuminac are often of good quality, and when properly prepared this material burns well. The proximity of the Pictou coal fields, and the cheapness of coal, is at present such as not to warrant the expenditure of capital in the preparation and manufacture of peat fuel, though for local purposes it might possibly be advantageously employed. **Peat.**

GEOLOGICAL SURVEY OF CANADA.

ALFRED R. C. SELWYN, LL.D., F.R.S., F.G.S., DIRECTOR.

REPORT

ON

PART OF THE COUNTIES OF

Richmond, Inverness, Guysborough and Antigonish,

NOVA SCOTIA,

1881

BY

HUGH FLETCHER, B.A.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

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1881

ALFRED R. C. SELWYN, ESQ., LL.D., F.R.S.,

Director of the Geological Survey of Canada, Ottawa.

SIR,—I beg to present herewith a report of the work of the Geological Survey in eastern Nova Scotia during the season of 1878 and 1879.

A preliminary reconnaissance of the northern part of Cape Breton Island from St. Ann's to Cape North, and thence along the west coast to Margaree, was likewise made in 1878 by my assistants Messrs. William Fletcher. B.A., and D. Christie, the details of which are, however, reserved pending further examination of that interesting region. This will be effected during the present summer.

I have the honor to be,

Sir,

Your obedient servant,

HUGH FLETCHER.

OTTAWA, 1st May, 1881.

REPORT

ON

PART OF THE COUNTIES OF

RICHMOND, INVERNESS, GUYSBOROUGH AND ANTIGONISH, NOVA SCOTIA.

BY

HUGH FLETCHER, B.A.

In continuation of the work of previous years in eastern Nova Scotia a geological survey was made during the summers of 1878 and 1879 of portions of Richmond, Inverness, Guysborough and Antigonish counties, bounded on the south by Chedabucto and St. Peters Bays, and on the north by Judique and River Denys Basin; as well as a preliminary examination of the country between Judique, Mabou and Whycocomagh, the result of which will be reserved for a future occasion. **Area examined.**

It is impossible to lay down geological lines without an accurate map, and no maps of this district having yet been published, except the Admiralty charts of the coast and Church's county maps of Antigonish and Guysborough (on which the roads only are correctly shown); and Crown Lands plans being also exceedingly fragmentary and imperfect, it was necessary to make close and careful surveys of nearly all the roads, streams, lakes and a large part of the sea-shore, which were plotted on a scale of twenty chains to an inch, and afterwards reduced by the eidograph, with the Admiralty charts as a basis, to one mile to an inch. Accuracy was the more important because within the region is included the Richmond coalfield, in the exploration of which about $100,000 have probably been expended, yet with regard to which very little is definitely known. **Map.**

All the courses were taken by prismatic compass. In 1878 the distances were determined on the roads by chaining and pacing and on the streams and shores by pacing; whilst in 1879 most of the roads were measured by means of an improved odometer, made under the direction of Mr. Wallace Broad, B.A., by E. Chanteloup of Montreal, by the use of which additional accuracy was attained and a greater distance surveyed, with singular ease, by one person than could be accomplished by two or three with the chain. **Method of surveying.**

Acknowledgement of assistance.

In the fieldwork I was assisted as in former years by Messrs. William Fletcher, B. A., of Toronto, Hartley Gisborne of Ottawa, and John McMillan of East Bay, Cape Breton, to whose indefatigable exertions, often in an unsettled country and in inclement weather, I am greatly indebted. Among others, our thanks are specially due to Messrs. J. E. Burchell of Sydney, John and Allan McDonald of Soldier Cove, Donald John McDiarmid and Alexander McCuish of Lochside, E. G. Millidge, C. E., E. J. Barclay, C. E., Charles Palmeter and J. D. Matheson of St. Peters, James Morrison of River Tillard, George Shaw, J. J. Robertson, C.E., Thomas Jean, George Andrew, William Creighton and E. P. Flynn, M.P. of Arichat, W. J. Morrison and Angus Ferguson of McLeod's Bridge, Captain John Stapleton and Captain Angus Grant of Hawkesbury, N. J. Brown and J. G. McKeen of Hastings, William Wylde of Mulgrave, Allan McQuarrie of Dorton's Bridge, Rev. Archibald Chisholm and Rory Chisholm of Judique, Samuel Campbell of Southwest Mabou, Dr. Honeyman, Edwin Gilpin, M.A., and James H. Austen of Halifax, Alexander McBean of the Vale Colliery, Pictou County. To the kindness of W. A. Hendry, Esq., of Halifax, we owe the Richmond and Inverness county line.

Character of the country.

In a general way the country is similar in physical features to that described in the Reports for 1875-78. In the vicinity of St. Peters Inlet and towards the head of West Bay and the Strait of Canso no

Hills.

hills of importance occur, and a great part of the land is unfit for agriculture. The hills of Madame Island, nowhere exceeding 250 feet in height, are separated from the Sporting Mountain (630 feet) by a wide valley which includes Lennox Passage and the low land to the northward, and these are in turn separated from North Mountain (768 feet) by West Bay, whilst the valley of the rivers Inhabitants and Denys lies between North Mountain and the Craignish Hills (1000 feet). The slopes of these hills are steep towards West Bay and the Gulf of St. Lawrence but gradual inland. In Guysborough and Antigonish counties, on the south side of the Strait of Canso, a range of hills of which the highest is Cape Porcupine (640 feet) rises abruptly along the Strait

Scenery.

and presents "in the solitude of rocky streams and leafy trees" many romantic scenes, one of the best known of which is Hartley's waterfall at Pirate Harbor, more interesting perhaps to the botanist than the geologist because of the occurrence of certain rare species of ferns. Views of striking beauty abound on West Bay in the more imposing Sporting and North Mountains, whose greater picturesqueness, however, entails rough walking and toilsome climbing. Marble Mountain is one of the most charming places on the Bras d'Or Lake. Here firm, extensive beaches afford safe and excellent bathing.

Brooks.

The streams are long, considering the nature of the country. River

Inhabitants rises, seventeen miles from its mouth, within three miles of the Long Point shore; and north of Glendale another branch has its origin near the sources of Denys, Graham and Southwest Mabou Rivers. These rivers originate among the hills in innumerable tiny streams from marshes and lakes or bubble out clear and cold from the foot of some rocky cliff; rush down the rugged and precipitous sides of the mountains, plunging over rocks or hurrying through dark and gloomy ravines; and unite to stray in the lower reaches among rich meadows and farms, at different seasons as clear winding rivers or turbid, swollen, irresistible floods, sweeping to destruction bridges, hay and other obstacles. Diogenes Brook, a tributary of River Inhabitants, affords one instance of a stream disappearing beneath a cliff of limestone to emerge again as a strong spring; and another example of this phenomenon on a smaller scale is seen where a brook flows through a gypsum cliff into the pond at the head of Plaster Cove. The streams flowing from the steep sides of the hills that look towards West Bay and the Strait of Canso are short and rapid: those on the opposite slopes are longer and less turbulent.

Lakes abound in the southern part of this district, but are rare in the north owing to the more elevated character of the country. In the mountainous districts few lakes occur; on Madame Island and in Guysborough county, which is comparatively level, most of the rivers take their rise from the lakes. Grant, Summers, Buchanan and Paddy's Lakes have each two distinct outlets, whereas the water of some of the plaster ponds has no visible means of egress. Their surface is often specked with flocks of waterfowl—ducks, geese and loons—and in many of them trout, salmon and gaspereaux abound. Lakes.

The sea coast east and south of the Strait of Canso is greatly indented and guarded by far-extending rocks and islands which render the approach to the harbors perilous and difficult; whilst between the strait and Judique it is unbroken, often flat and without harbors. The cliffs seldom descend sheer into the water, and can therefore be examined; but long stretches of the shore are devoid of rock outcrops. Sea-shore.

Scattered everywhere along the sea-shore are villages and hamlets inhabited by fishermen, usually surrounded by sterile and unproductive land covered here and there with stunted trees. Farming is prosecuted in the rich valleys of some of the rivers and around the Bras d'Or Lake. The settlements on Madame Island and at River Moulin, Seal Cove, River Bourgeois and Beaver Island are chiefly French; with these exceptions the population of the north side of the strait is of Highland Scotch descent, that on the south side of mixed origin. Villages.

As in Cape Breton county, the hills are composed either wholly or in part of precarboniferous, and the valleys, of softer, carboniferous General geological structure.

Carboniferous basin.

rocks, forming anticlines and synclines respectively. The general form is that of a great basin of carboniferous strata, interrupted by the older rocks of the Sporting, North and Craignish Mountains. The rim of this basin follows St. Peters Inlet, Lennox Passage and the Strait of Canso; and its highest rocks are found about two miles north of Inhabitants Basin. Underlying these upper rocks are the plaster and limestone of Little River together with the coal seams of the Richmond coalfield and River Inhabitants, extending down to the belt of plaster and limestone of Plaster Cove or Hastings, which is probably equivalent to that of Lennox Ferry and St. Peters and may be regarded as the base of the carboniferous system. Unconformably beneath the limestone come the slate, sandstone and conglomerate of Madame Island, McMillan Point and Guysborough, which are cut in many places by dykes and masses of diorite and trap, probably irrupted after the deposition of the limestone, at least in the neighborhood of St. Peters. Then follow the George River limestone and the felspathic group. The strata being greatly faulted and contorted their relations cannot be unravelled with as much ease as in Cape Breton county.

These formations will be described as follows:

Groups of rocks

Precambrian. { Syenitic, Gneissoid and other Felspathic Rocks.
George River Limestone.

Devonian Metamorphic Rocks.

Carboniferous Rocks.

PRECAMBRIAN.

Syenitic, Gneissoid and other Felspathic Rocks.

These as already remarked, occupy well-defined areas in the south-eastern part of Madame Island near the county town of Arichat, at Cape Porcupine on the Strait of Canso and in the Sporting, North and Craignish Mountains. On Madame Island they consist chiefly of felsites like those of Louisburg, resembling sometimes also the intrusive rocks near St. Peters. At Cape Porcupine, slates are associated with coarse syenite* and Louisburg felsite; in the Sporting Mountain the felsites occur with red syenite; whereas the North and Craignish Mountains consist principally of reddish syenite, overlaid here and there by crystalline limestone and other rocks of the George River series.

Arichat Felsites.—At Shaw Point on Rocky Bay is a small patch of purplish and greenish diorite, felsite and quartz-felsite, often vesicular and amygdaloidal, containing much chlorite, epidote and calcspar in

* The term *syenite* is applied in this as well as previous reports on Cape Breton, to a mixture of quartz, potash- or soda-felspar and hornblende; *diorite*, to a mixture of felspar (usually soda- or lime-felspar) and hornblende.

veins. At Fourgier Point, dark-green, light grey and red porphyritic felsite, stained with hematite, appears from beneath devonian strata; and at the head of Bewes Pond a finely laminated, compact, splintery porphyry dips N. 19° E., running thence along the south shore of the pond on a coast of the character usually formed by these rocks—rough, and indented, with outlying points and submerged rocks. These change from compact to granular and at the eastern point dip N. 10° E. Ranteleau Point exhibits huge blocks of a black mixture of hornblende and felspar. The hornblende predominates and occurs also in large porphyritic spots. Epidote is found in the joints and as minute veins.

Around Petite Anse bright flesh-red felsite, quartz-felsite and dark diorite underlie the devonian grey conglomerate. Further south is a curious outcrop of greenish and reddish calc-veined, compact rock with a northerly dip, only a small portion of which is bedded. Generally it resembles a compact felsite of the Louisburg series, but in places an altered form of the sandstone and conglomerate, or a hard coherent argillite. A bluish-grey variety is seen at low water, full of calcspar with traces of gypsum; it contains masses of bluish limestone, and is not unlike a doubtful felsite seen near Grand River bridge. Perhaps it should be regarded as intrusive and post-devonian or as a part of the conglomerate which it appears both to overlie and underlie. **Petite Anse.** **Calcareous rock.**

On the north-west corner of Green Island is a dark bluish-grey compact quartz-felsite, containing mica in very fine specks and black splendent hornblende in waving bands one to two inches in thickness. This rock is very heavy and has a metallic ring when struck. Chlorite ramifies in all directions through it; and quartz veins also occur, some of which are an inch and a half thick, run regularly for ten or twelve feet and carry specks of iron and copper pyrites with an iridescent tarnish. On the highest point of the island where the lighthouse stands, the same hornblendic quartz-felsite is seen, while conglomerate blocks prevail on the slopes. Quartzites, containing only patches of felspar, dip steeply northward at the south-west corner. On the south they are much contorted and dip N. 20° W. The dip at the south-east corner is the same, at the east end, S. 40° E., and on the north and north-east, S. 20° E. at a high angle. **Green Island.** **Quartz veins.** **Copper ore.**

On the north side of Mackerel Cove green, bluish, purple and grey, porphyritic felsite, quartz-felsite and diorite, with films of hematite in joints, are exposed with buff compact quartz-felsite and mottled fragmentary felsite, probably belonging to this series. On the south side felsites of many colors are intimately mixed. A compact salmon-colored variety appears in lenticular masses throughout green chloritic felsites, which are veined with calcspar and mixed with dark-green diorite and fine waving, contorted quartz-felsite and felsite-breccia. **Mackerel Cove porphyry.** **Breccia.**

Iron ore. Small quantities of hematite occur in threads and films. These rocks extending to Presquile Cove are there overlaid by conglomerate.

Crid Islands. On the most easterly of the Crid Islands, a patch of dark bluish-green dioritic felsite, interbedded with light and dark salmon-colored, compact, hematitic and chloritic felsite, becoming coarse-grained, extends about forty yards from the eastern point and is capped by conglomerate.

Arichat. Two parallel bands, of varying width, of rocks precisely like those just described extend from near the shore of Rocky Bay to the westward of Arichat.

Sporting Mountain Felsites.—The second ridge of these rocks forms the Sporting Mountains, which run from the vicinity of St. Peters Inlet close to the shore of West Bay as far as Black River. An outlying spur forms the nucleus of Ballam Head, while another extends to the rear of McPherson's on the St. Peters road. Outcrops are everywhere displayed in the brooks, and a brief description will here be given of the principal ones, beginning at the north-east extremity of the hills near Scott Brook.

Morrison Harbor. In one of the streams flowing into West Bay east of the Morrison road is a greenish porphyritic felsite, with a few grains of hornblende mica and quartz and films of hematite, which weathers in places bright flesh-red. In another of these streams, greenish and grey compact and granular quartz-felsite, with a little hornblende, passing into syenite, diorite, felsite and imperfect gneiss, is met with near the shore road, associated with soft greenish, pearly, aluminous slate, apparently irregularly bedded, and with coarse-grained quartz-felsite in layers one to six inches thick, which breaks along planes covered with films of hematite. These have a striking resemblance to the Capelin Cove strata (Report for 1877-78, p. 9 F.) and, although massive-looking in the cliffs, closer examination shows a strike up stream of the fine interlocking laminæ of the rock. The brook runs in a continuous gorge above the road.

In the brook just west of the Morrison road, similar rocks are well exposed in gorges and cataracts. They comprise:

1. Reddish, fine syenite with very little hornblende and streaks of chlorite.
2. Nearly compact felsite and diorite with films of hematite. In places the hornblende and felspar are distinct, forming a fine, granular, black and variegated rock.
3. A breccia like that of Louisburg and Cape Rhumore.
4. Greenish and reddish fine diorite, passing into coarse syenite.
5. Reddish quartz-felsite or chloritic syenite containing minute traces of copper carbonate. (Copper ore.)
6. Greenish, soft, calcareous, soapy, granular, shaly rocks, containing felspar and hornblende together with a serpentinous mineral. Dip S. 38° E. $<$ 80° but variable.

7. Diorite dipping as above.
8. Greenish, grey and whitish Louisburg shales, passing into granular diorite and syenite. Calcspar often present.
9. Diorites and altered diorites with chloritic, very calcareous, soft rocks.
10. Soft and hard, soapy shales, containing granules of quartz. Sometimes they resemble the whitish altered felsite of McKeagan Brook (Report for 1875-76, p. 424) assayed by Mr. Hoffmann and found to be suitable for the manufacture of fire-bricks.
11. Bright variegated breccias like those of Louisburg, or of more sober tints, with close-set oblique interlocking plates. Most of the rocks are friable and often soft, but others consist of pure felspar and are hard and splintery.
12. Near the source of the brook, shales and diorites are associated with grey or reddish, jointed, massive syenite, coarse and epidotic, containing also mica and iron pyrites.

This brook, rising from a mossy marsh, runs into a glade along which grow maple, beech and birch. Between its source and the Morrison road is a wet, brown, mossy barren, underlaid by felspathic and dioritic rocks.

In Hill's Brook, near the post-office, diorite in well-defined layers strikes S. 60° E., with massive and granular or laminated, porphyritic, felsite. In the adjoining brook is a quartzo-felspathic rock in which quartz greatly predominates and is also abundant in the form of veins; associated with grey and reddish granular syenite and compact felsite, and succeeded, higher up, by bottle-green epidotic diorite. Hill's Brook.

The large beautiful brook east of Robert Morrison's is bordered by rocky overhanging cliffs surmounted by birch and maple, whose leaves are painted in the dark water of the pools in which the brook rests for a moment after dashing over the jagged rocks in white foaming cascades or small vertical falls. The following succession is displayed above the road:

1. Purplish, compact, epidotic, massive felsite, not well exposed.
2. Purplish finely laminated felsite.
3. Coherent, fragmentary, nearly compact Louisburg felsites, with pearly planes. Blotches of quartz and vugs containing large crystals of that mineral. Dip S. E. $<60°$.
4. Epidotic fragmentary felsites with all the bright colors of the Coxheath and Louisburg series. Small cubes of iron pyrites, also traces of hornblende and chlorite.
5. Compact felsites and fragmentary rocks in great variety containing much quartz; often finely crystalline and mixed with chlorite.
6. Light-grey and greenish, pyritous, rather massive felsite containing many granules, blotches and veins of quartz and hornblende.
7. Dark diorite and grey and light-green felspathic shales and compact pyritous felsite and quartz-felsite, variable in color and texture, passing into one another. Such changes are common among the laminated rocks, the lamination being preserved through all the changes. In some of the

mixtures the quartz gradually predominates and a quartzite results. Dip south-easterly.

8. Granular syenite and diorite, passing into syenite which occupies the brook and forms gorges and rapids. One cascade is very beautiful being about ten feet high and triangular.
9. Beautifully mottled, fine Louisburg felsite-breccia, granular in structure. The brook rises from a marsh full of small frog-ponds.

Pringle Brook. Near West Bay, reddish and grey syenite, felsite and diorite strike across the Pringle road. In the large brook crossing from Pringle Lake similar rocks are seen, blotched with quartz. The stream is wild and rocky, black and turbulent, running between rugged cliffs in gorges and foaming falls. From Pringle's mills westward the road skirts the boundary between the felsites and carboniferous rocks, the former being well exposed in all the brooks. In one of these, at a shingle mill, purplish trap-like rocks, greenish and purplish, compact, porphyritic, massive felsite and aluminous shales, one-eighth of an inch thick and upwards, occur with greenish fine diorite in which felspar and hornblende are well mixed. Above the fork, in the left branch, Louisburg felsites of every shade of color and accompanying soft calcareous pearly slates, alternate with syenite and granular diorite; and interesting transitions from one variety to the other are frequent. Quartz veins, often an inch thick, run irregularly in the bedding, and epidote is also present. In the east branch of this brook, a compact purplish and bluish felsite shows white porphyritic spots of felspar; it is obliquely jointed, thick-bedded and associated with a white compact felsite and dark purple porphyry, containing crystals of felspar an inch in length. Among other varieties are red syenite and dark-purple, finely-laminated, soapy, contorted, aluminous shales.

Trap.

Quartz veins and epidote.

Large crystals

In other brooks to the westward and on the shore road, reddish-brown and dark purple felsite, with white, black and yellow spots and streaks, jointed and with hematite in some of the joints, is mixed with grey and coarse syenite. Fine black glittering specks, perhaps of magnetic iron, occur in some of the purple felsites.

Magnetic iron.

The outlier south of Ballam Head consists of dark bluish-grey compact felsite well seen in the brooks that follows the northern boundary between the precambrian and carboniferous rocks. In several branches of Black River the western outcrops of these felsites are met with. The southern spur of the hill was traced across the Grand Anse and Grandique roads to its termination near McPherson's. In one of the Grand Anse brooks is a fine-grained hornblendic gneiss containing a few specks of mica associated with a compact mottled syenite presenting the appearance of Castile soap.

Gneiss.

River Tillard. In the western branch of River Tillard below Mountain Lake, under-

lying the conglomerate, sandstone and shale comes blue, green, white, purple and mottled porphyritic felsite breaking into small pieces, succeeded higher up by coarse grey diorite and syenite in which the constituents are well mixed. The felsite appears to dip to the south-east, but no lines of bedding are visible in the syenite. A deep pool and celebrated series of falls occur in this brook in the syenite which is curiously inclined on either side to the running water.

In more easterly branches of River Tillard, which cross the Morrison road, these rocks are also seen in contact with newer strata, and consist of greenish, granular and porphyritic, chloritic diorite, mixed with greenish and reddish rather friable syenite, and with mottled greenish, red and purple, soft, soapy shales. **Syenite and aluminous shales.**

North of the road to Malcolm Ross' house, grey and rusty, pyritous, somewhat pearly, laminated felsite and diorite dip S. E. $< 70°$ at the junction of a coarse and coherent carboniferous conglomerate.

Guysborough Felsites.–These may be regarded, for the most part at least, as an extension of the felspathic rocks of the Craignish Hills, from which they are separated by the Strait of Canso. Their greatest development is at Cape Porcupine, a hill which rises abruptly from the strait between Auld Cove and Port Mulgrave, having in its centre a series of slates surrounded by syenite and felsite. **Cape Porcupine**

South of the old cable-landing, epidotic porphyritic felsites, of grey, bluish and other colors, veined and blotched with quartz and calcspar in a direction S. 3° E., which seems also to be that of bedding, are close to the slates. Further from the contact there is great variety in the color and texture of the rocks, some beds being obscurely gneissoid like those of Capelin Cove. The last of the slate series to the southward are bluish-grey flinty quartzo-felspathic sandstones or compact quartzites, full of quartz and resembling the cambrian rocks of Framboise and the vicinity. (Report for 1877-78, p. 15 F.) Further inland the slates are greenish-grey and soft, cleft across the bedding, jointed and pyritous, silky and containing serpentine in irregular planes. They are essentially argillaceous but include compact quartz-veined quartzites, which, however, do not appear to be persistent. On the north side of the slates, near the end of the path from Auld Cove, syenite and soft calcareous diorite are irregularly mixed on the shore. A light bluish-grey quartzite or quartzose grit, like that of Framboise, abuts against the syenite, which is here full of small veins of quartz and calcspar, and intersected by dark-green diorite. The contact is peculiar. On the west side a band of grit and quartzite, varying from ten to sixteen feet, runs S. 10° E. into the hill as far as seen, the separating bed being a reddish compact quartzose felsite, full of white veins and probably belonging to the syenite series. On the east side the line of contact is curved and the **Felsite.** **Quartzite.** **Slates.** **Contact of quartzite and syenite.**

quartzite appears to lie as it were on the dark quartz-felsite and porphyry that succeed. Another band of quartzite is found among the felsites at no great distance, mixed with patches of silky quartz-veined bluish-grey slate. Then comes a large exposure of these rocks, succeeded by a greenish, rough, compact and fine-grained, soft, calc-veined diorite dyke which converts the slates in contact into flinty felsites. The slates are perhaps most like those of River Denys, which accompany the mica-schists and crystalline limestone. The felsites may be older, but are more probably of contemporaneous or subsequent igneous origin; they appear to be both bedded and intrusive and with the syenites quite surround the slates which seem to rest upon them in basin, form, as shown on the map. There is no question of all being older than the Clam Harbor or devonian rocks, both from their appearance and stratigraphy, but that they are precambrian can only be inferred from their resemblance to the rocks of the other side of the strait. The slates being often twisted, the quartz and other hard bands sometimes assume a "barrel" shape; and in other ways they resemble the gold-bearing rocks of Nova Scotia, as well as the doubtful rock found on the French road near Gabarus and the strata of Shenacadie. Slaty cleavage is always more distinct than among the devonian rocks. They contain traces of iron pyrites and are greatly contorted. Sometimes they are silky, hard and coherent, assuming the character of felsite, veined with milky quartz, like that of River Denys cross roads, in common with which they have been supposed to carry gold.

Dyke.

Barrel quartz.

Slates supposed to be auriferous.

Stewart Pond.

Not far west of Stewart Pond is an outcrop of rock which may belong to this series but is perhaps newer and intrusive. As the neighboring rocks are generally felsitic conglomerates and the felsites appear to be at no great depth, they may, in the absence of more definite information, be placed in this position. They comprise trap-like and felspathic rocks of various colors, sometimes compact sometimes coarse or fine grained. In general they are like the trappean hematitic rocks of Gregwa Brook. (Report for 1876-7, p. 412.) The surrounding shales are purplish like those of Salmon Creek district. (Report for 1877-8, p. 23 F.)

Another outcrop of syenitic, probably precambrian, rock is met with in Goose Harbor River above the shore road.

Craignish Felsites.—Nearly the whole mass of the Sporting Mountain is composed of Coxheath felsites, whereas only the southern portion of the Craignish Hills is so constituted, the northern part being made up chiefly of coarse syenite and granite capped by the crystalline limestone and gneiss series.

Port Hastings.

Immediately east of McMillan Point near Port Hastings, beneath the metamorphic rocks there met with, is a small exposure of bright green

chloritic and calcareous felsite and coarse syenitic rock. It would perhaps be rash to assert that this is not an intrusive rock belonging to the devonian metamorphic series, the actual contact of the slates not being seen; yet, taken in connection with the fact that felsites of the Craignish Hills are not far distant and that a similar rock underlies the slates and sandstones at Cape Porcupine opposite, it seems more probably a knob of the pre-cambrian group.

North of Long Pond at the shore road, is a larger similar outcrop of greenish calcareous felsite with a few small veins of calcspar and specks of iron pyrites, jointed in every direction and containing hematite in the joints; associated with a dark-grey calcareous rock. **Long Pond.**

In two places in Horton Brook below the lake, are roughly bedded or jointed dark-purplish, granular felsite and amygdaloid with amygdules of calcspar and chlorite, which may also belong to the devonian series rather than to this. On the north shore of the lake are outcrops of massive, splintery, greyish and bluish, granular and compact felsite and quartz-felsite, which look in places like altered syenitic and felsitic grits. In the hills north of the lake, conglomerate and grit appear unconformably spread over felsite and diorite. Near the Lake Horton road, coherent grit and conglomerate are underlaid by dark purplish fragmentary and amygdaloidal, epidotic felsite, vesicular on the surface, and by coarse diorite. In the brook above the lake is a grey amygdaloid, yielding easily to the knife, the grey grit in the neighborhood being nearly horizontal. It has no bedding, is greatly broken and often resembles argillite. On the track from the head of Horton Brook to the General Line road, grey coarse syenitic rock occurs. An outcrop, probably continuous with those in Horton Brook, is first seen to the eastward of Long Pond and thence trends northward towards Craignish. It consists of greenish-grey fragmentary felsite, blotched with quartz, overlaid by grey conglomerate. In one of the little brooks to the northward grey coarse syenite is in place, overlaid by coherent conglomerate. At Craignish, grey and violet epidotic felsite and quartz-felsite occur with fine-grained, dirty brown jointed diorite, in which the felspar and hornblende cannot be distinguished, and an amygdaloid with amygdules of calcspar, felspar and quartz. On the shore road, diorite and quartz-felsite occur, and in one of the small brooks north of the chapel greenish, soft, pearly, laminated cleft Louisburg shales strike N. 33° W. with dark-green finely crystalline amygdaloidal diorite. On the Craignish road near the shore, are the following varieties: **Horton Brook amygdaloid.** **Craignish.**

1. Dark-green fine diorite and light-reddish compact and granular felsite and quartz-felsite, sometimes with minute vugs lined with crystals of quartz.
2. Yellow-spotted compact felsite, usually with a tinge of red or purple.

3. Compact or nearly compact felsite or diorite mixed with light-reddish, very epidotic quartz-felsite, more or less granular.
4. Light and dark-greenish felsite, quartz-felsite, diorite and syenite, compact and coarse-grained. When the felspar predominates the rock is compact; fine-grained when hornblende is abundant, and distinctly granular when there is much quartz, although patches of compact quartzite also occur. There are masses of twisted, obscurely laminated rocks, like those of Louisburg, but as a rule the bedding is not plain and the rocks are for the most part syenitic.

Age of the Coxheath felsites.

The distribution of the Coxheath and Louisburg felsites here lends strength to the assumption that they belong to the syenite series and are older than the crystalline limestone series which appears at no great distance from them and distinctly overlies the syenite into which these felsites insensibly merge.

North-west arm of R. Inhabitants.

North of the General Line road in the North-west Arm of River Inhabitants are fragmentary felsites, generally grey, resembling those of Louisburg, and possibly, igneous rocks invading the metamorphic strata. It is never difficult to distinguish between the felsites and the carboniferous rocks; and there is also very little doubt that the great mass of the felsites is older than the metamorphic rocks of the neighborhood instead of the cause of their alteration. But these rocks are all so much altered that it is hard to prove that the felsites are not intrusive in certain cases, where they are not themselves bedded. Further examination of some of the principal doubtful points of contact is necessary to determine this question.

Brown's Brook.

In Brown's Brook above the General Line road are purplish, grey and reddish, porphyritic, fragmentary rocks, sometimes soft and with difficulty distinguishable from argillites; but further from the contact hard and coherent. They resemble the rocks of Cape Rhumore, are calcareous and hematitic, having an oblique slaty cleavage in addition to a variable northerly vertical strike. In the bed of the brook is a three-feet band of whitish, spotted, calcareous rock, so soft as to be easily ground to powder by the fingers and full of minute crystals of quartz, standing between two walls of red felsite, not persistent but disappearing both ways on its line of strike. Higher up the brook are cliffs of greenish granular diorite, compact and fragmentary, porphyritic felsite of different colors, and other rocks of the series, including a reddish-grey granular quartz-felsite.

Heffernan Pond.

About the farm road crossing from Heffernan Pond to the General Line road, the coherent grits, slates and conglomerates are underlaid by greenish felsite and dark diorite. Not far from the brook, coarse syenite, with grains of quartz about the size of split peas, weathers whitish-grey and appears again in other brooks of the neighborhood associated with quartz-felsite and felsite.

The prevailing rock of this series about Queensville (The Ridge) is a reddish or grey coarse syenite, often containing little hornblende and passing into felsite, quartz-felsite and diorite, cut in various directions by many dark-green dykes. One of these dykes is distinctly marked off from the syenite by jagged edges. It is not easy to determine whether the appearance of bedding often seen in the syenite is a system of jointing or obscure gneissic foliation. Queensville.

In the upper part of Queensville Brook, felsite and syenite are intermixed and all the brooks of the region show similar transitions from one rock to the other.

The Rough Brook of River Inhabitants is, as its name implies, a hard brook to follow, owing to the large rounded blocks, dangerous slippery outcrops and the cascades and rapids which frequently occur in its bed. Near its source it flows over light pink syenite with an apparent dip of E. $< 45°$, associated with quartz-felsite, containing a little hornblende and passing into a mixture of quartz and hornblende. The syenite is sometimes compact and veined with dark-green calcareous, pyritous, epidotic diorite, but also very coarse; it contains many specks of a light-green soft mineral. Below the path at Donald McIsaac's, coarse reddish-grey syenite is cut by many small dykes of greenish-grey diorite and by a blue massive fine-grained, crystalline mixture of hornblende and felspar, with blotches and veins of epidote. One of these dykes is about twenty-five yards wide. In places there is a passage of the syenite into compact felsite and quartz-felsite, intersected by irregular lenticular veins of barren quartz, about an inch in thickness. Rough Brook. Dykes. Quartz veins.

The first precambrian rock seen above the Victoria road in McMaster Brook is a bluish-grey, pyritous, fine diorite and splintery quartzite, probably belonging to the George River series. This is succeeded by reddish-grey syenite the surface of which is rough with small prism-pyramids of vitreous, colorless quartz. Similar syenite, containing little hornblende, alternates with occasional exposures of diorite for some distance. McMaster Brook.

The hills about Glendale consist principally of coarse and fine syenite, passing into reddish and grey felsite, veined with milky quartz. In one of the brooks below River Inhabitants road is an example of the passage of a fine, jointed syenite into red felsite, quartz-felsite and diorite. Similar rocks occur in River Inhabitants below the red bridge, and in the brook behind McGillivray's, at the graphite mine, a very coarse red syenite is full of specks of graphite. Perhaps the graphite of the shales at the mine (Report for 1878-9, p. 2 H.,) was derived from this source. Glendale. Graphite.

Passing up McPherson Brook from River Inhabitants road, red and McPherson Brook.

dark steel-grey, fine and coarse syenite and diorite are met with, containing minute crystals of iron pyrites. Sometimes the grains of felspar appear on the surface as large white spots. Crystalline limestone rests upon the syenite which also occurs beyond. The syenite is very coarse, quartz and felspar predominating. The latter is in large flesh-red crystals; the quartz in crystals sometimes as large as a pea, the hornblende often in semi-crystalline pockets. The syenite dips doubtfully N. 20° E., and is followed up stream by a rock consisting almost wholly of hornblende, and by various other rocks, including a crystalline limestone, which seems to dip in the same direction as the syenite. The occurrence of hornblendic, coarse, porphyritic and gneissoid rocks in the neighborhood of the George River limestone has been frequently noticed and may have some bearing on the question of its metamorphism.

Contact with limestone.

South-west Mabou River.

In the branches of South-west Mabou River which flow from River Denys road, red syenite is met with for some distance down; and is then overlaid by grey, hard, quartzose sandstone. The brook near Squire McDonald's shows only grey, greenish and reddish syenite and granite mixed, whereas in the adjoining branch of River Denys slaty and well stratified rocks are seen. On the River Denys road hematitic syenite succeeds laminated rocks.

Graham River.

After passing the marshes and meadows, near the source of the main branch of Graham River, rapids and cascades are met with in syenite, sometimes imperfectly granular, fine crystalline diorite, and a gneissoid rock probably connected with the crystalline limestone of the neighborhood. The syenite is often epidotic, and cut by dykes of quartz-veined, calcareous, hornblendic rock, probably of the same age as those which penetrate the overlying grits and conglomerates. The number of diorite dykes is somewhat remarkable; thin bands run in the syenite and large masses stretch across the brook. In one place a fine diorite surrounds a small piece of syenite.

Dykes.

Chisholm Brook.

In the north branch of Chisholm Brook, pink quartz-felsite, dark bluish-grey, compact, yellow-streaked diorite and syenite underlie a quartzite. Perhaps the succeeding diorite is like those just described a newer intrusive rock. Syenite is found on the hills farther north, but need not here be referred to.

North Mountain Felsites.—The rock which generally underlies the crystalline limestone series in the North Mountain is, as before stated, a syenite. This is first seen near the road which runs from Big Brook road near the chapel to the head of West Bay, where dark-grey, ringing, compact syenite and diorite are overlaid by carboniferous sandstone. The syenite, composed almost wholly of felspar and quartz, passes also into a felsite as seen in some of the brooks, which exhibit fine

Passage of syenite into felsite.

falls. On the hills behind Mrs. Archibald Kennedy's, near the school, red sandstone detritus gives place to red coarse syenite which extends far back, although traces of carboniferous rock are found in some of the clearings on the top. In the north branch of McLeod Brook flesh-colored, fine-grained, slightly crystalline felsite is associated with an intimate mixture of quartz and hornblende, dark-blue felsite, containing small clear grains of quartz, and red coarse granite, in which the mica is golden and the felspar in large flesh-red grains. Diorite dykes occur in the red granite. Large blocks of crystalline limestone were also found, but none in place. On the road from West Bay to Big Brook, near the crossing of the south branch of McLeod Brook, and again nearer Big Brook, grey and reddish sandstones are succeeded by syenite, granite and quartz-felsite, generally reddish, in which the grains of quartz and felspar are often as large as marbles, and the mica is in small bronze-yellow, scattered plates. Descending the brook from the road, coarse flesh-red granite is met with, having an obscure south-east vertical trend, in thick layers, penetrated by greenish dykes. It forms several cascades, massive mural cliffs thirty feet high, and small caves. Lower down it is overlaid by bluish-grey, carboniferous, argillaceous shale with a high northerly dip. The brooks of the neighborhood, rising from cold, clear springs, soon cut deeply into the granite and syenite, increase rapidly, and rush into the carboniferous lowlands. In Ross Brook, exposures of dark porphyritic felsite are seen, with white and grey syenite, in which the quartz greatly predominates. Sometimes the different constituents run in streaks or are separated in patches. In the same neighborhood mottled white and yellow marble, in thick beds, interstratified with white quartzite containing mica, abuts against a quartzite.

McLeod Brook.

Ross Brook.

Marble.

On the shore of West Bay at Ross Creek red syenite crops from beneath a limestone and conglomerate, being, near the contact, strongly seamed with hematite. It is sometimes compact but usually granular, the grains being often as large as peas. On the roads over the hills between this creek and Big Brook, these rocks are also met with. Among the more interesting varieties is a light-grey granite, consisting of flesh-red felspar, the grains of which are as large as walnuts, pure white quartz and very little mica. A brownish-grey compact felsite also appears with bluish-grey coarse syenite and an intimate mixture of quartz and hornblende.

Ross Creek, West Bay.

The path from John McInnes' to John McCuishpig's passes over syenite and diorite, the latter sometimes coarse and grey, with grains of felspar as large as peas. In the south branch of Ross Brook below this track, are dark-green diorite, fine-grained syenite, hard quartzose felsite, grey granite, gneiss and calcareous quartzose felsite. A vein of six inches of quartz runs in a northerly direction.

In all the brooks between Ross Creek and Little Harbor these rocks are found beneath the crystalline limestone. In a brook near the North Mountain church, grey and reddish granite, usually coarse but sometimes fine or nearly compact, containing bronze or black mica, reddish and whitish felspar, white quartz and, occasionally, grains of hornblende, strikes apparently up stream. Syenite occupies most of the country near Marble Mountain, associated with the crystalline limestone, as shown on the map.

North Mountain.

River Denys.

On the River Denys side of the mountain good exposures are also everywhere present in the brooks, all of which have been examined. A few points of interest with reference to these may be stated. The syenite is sometimes cut by porphyritic dykes and passes into granite containing golden mica. Sometimes the rock is felsite, sometimes it contains a large proportion of quartz, and thin seams of hematite often occur. In the gorges of McKenzie Brook is a reddish, coarse, jointed syenite, running into a granite with grains of milky quartz as large as hazelnuts, reddish felspar, silvery mica and greenish-black hornblende. Irregular joints are stained with hematite.

McKenzie Brook.

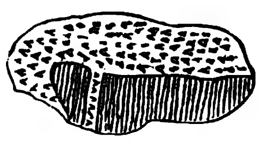
McIntyre Brook.

Some distance above the old mill in McIntyre Brook near River Denys, red coarse syenite, containing mica, is the prevailing rock, although greenish pyritous diorite also appears. A good many small falls occur between the lake and the road, all exhibiting these rocks, which are also exposed in the neighboring hills.

Search for coal!

Gneiss mixed with syenite.

In the millbrook, a tributary of Big Brook further south, the reddish and grey syenite contains much mica and calcspar in seams. In this syenite a hole has been dug to search for coal, pieces of which are reported to have been found here. At the mill, greatly contorted gneiss is mixed with coarse syenite, one block presenting the appearance shown in the annexed figure. The syenite seems to be part of



a vein cutting the gneiss, yet in places there is a distinct passage of the gneiss into syenite.

In one of the branches of Princeville Brook the syenite is composed chiefly of greenish-black hornblende and felspar with pink patches of felspar and quartz, jointed in every direction, and with a yellowish-green mineral in the joints. It is pink and grey in color and passes

into a pure quartz-rock. Near the marble which occurs in the brook it becomes a quartz-mica rock, and also a quaternary granite with streaks or veins of barren milky quartz. In a more southerly branch of this brook a coarse reddish mixture of felspar, quartz, hornblende and mica is associated with greenish, coarse, talcose granite and dykes of compact, porphyritic diorite.

Mabou Felsites.—Red, grey and greenish Coxheath felsites, often porphyritic, occur on the roads down the right bank of Mabou River below Mabou, but need not be noticed at present.

Precambrian or George River Limestone.

The description of the crystalline limestone series of the St. Anns and Boisdale Hills (Report for 1875-6, p. 381, et al.) is equally applicable to the more widely distributed rocks of this formation in the region under consideration. The opinion already expressed that this forms an overlying, unconformable group of precambrian age is greatly strengthened by the results of recent investigations, the limestones in every case capping the felsites, with which, however, they often seem to blend near the contact as if by a common metamorphism, such as that referred to by Dr. Honeyman in the Transactions of the Nova Scotian Institute of Natural Science, Vol. III., Part III., page 197. That the felsites were subsequently intruded or contemporaneous volcanic deposits seems less probable. **Unconformability.**

In the North Mountain and northern part of the Craignish Hills the rock underlying the limestone series is granular syenite, whereas in the southern part of the Craignish Hills it is in contact with the Coxheath felsites. No less than ten or twelve distinct outliers occur in the North Mountain and seven on the Craignish Hills, the limits of which have been defined with a considerable degree of care. Blocks are also found in other places, as for example near Craignish, perhaps indicating the occurrence of other outliers; and possibly the slates and quartzites of Cape Porcupine (p. 9 F) may belong to the series. A vivid contrast is often observed between the brilliant green of the foliage of the trees which grow on the crystalline limestone and the more sombre tints of the evergreens of the felsitic areas. **Distribution.**

Crystalline Limestone of North Mountain.—The most southerly outcrop of this group on the North Mountain is found in several streams near the source of Big Brook and on the road to West Bay, where whitish-grey crystalline limestone appears among the syenite, granite and quartz-felsite of the district. In the neighborhood of another outcrop of whitish marble, intimately mixed with felsite and with quartz which also contains serpentine, mica and a fibrous mineral, the syenite passes into micaceous and talcose granite and quartz-mica rock. A similar passage **First outlier.**

Benacadie Glen.

was observed in Benacadie Glen (Report for 1876-7, p. 411), except that there the limestone was not found in place; and it is likely that some of the laminated rocks of that district should be regarded as of the George River series, more especially as crystalline limestone containing traces of copper ore is said to have been discovered there.

Ross Brook outlier.

The second outlier is found in and to the eastward of Ross Brook, where, near John McCuish's road, grey syenite with very little felspar, contorted quartz and hornblende rocks are associated with quartz-felsite containing hornblende and quartz in veins and succeeded by white crystalline limestone about nine feet wide, which seems to abut against the syenite, dipping N. 25° E. The constituents of the syenite run in streaks, and in places a pure crystalline quartz results. On McCuish's road, red soil is seen near the water, but further inland, blocks of white marble appear, although syenite is the only rock found in place. On the tracks about McCuish's, a mixture of quartz and hornblende occurs with flesh-red quaternary granite, rather compact, with the quartz and felspar, hornblende and golden mica in small grains; and with compact, light-colored, subcrystalline or crystalline limestone, weathering white or dull grey, dipping N. 43° E. at a high angle, and of various shades of white, green and blue, spotted with some black extraneous matter. Seams of golden mica in fine scales run through the limestone, the layers of which are often less than an inch in thickness. On a neighboring track, thin and thick bedded limestone dips N. 64° W.; it is of a mottled greenish-yellow and white color and contains specks and streaks of black and silvery mica, so plentiful in places as to constitute the greater part of the rock. With the limestone is associated dark-greenish-grey and bluish felsite, seamed with greenish-yellow quartz and passing into white quartzite with a few specks of felspar and hornblende.

Relative position of the limestone and syenite.

Several brooks to the eastward of McCuish's exhibit only syenite, whereas limestone is present on the adjoining hills, apparently always overlying the syenite, the latter being cut into by the brooks in wearing out the gorges in which they run. Unless the limestone is newer than the syenite the latter must be intrusive, whilst the former represents patches of a series that has been lifted up and altered by it. But the syenite appears rather to be a more highly metamorphosed form of the felsites and gneisses upon which the limestone has been laid down, and in common with which it has afterward been altered. The proximity of the limestone may have influenced the products of metamorphism and have given rise in some way to the gneisses and coarse porphyritic mixtures usually found along the line of contact.

Dallas Brook outlier.

Another mass of these rocks occupies the shore of West Bay about Dallas Brook, and stretches westward towards the valley of River

Denys. In Dallas Brook at the bridge on the shore road, greenish shaly felsite dips about N. 25° W. < 60°. On the shore to the eastward, greenish-grey, compact, flinty felsite, jointed, massive and veined with quartz and calcspar occurs with cream-colored pyritous limestone, often epidotic, bringing to mind the rocks of Benacadie and Shenacadie. For some distance up stream, blocks of limestone abound. From the brook to the track to Kenneth Campbell's, the rocks are fine, massive, compact and felsitic, passing into contorted gneiss, some of which resembles highly altered argillaceous shale. Between Campbell's and the shore road similar rocks occur, perhaps more altered. In Campbell Brook, calcareous felsite succeeds the syenite and is accompanied by bluish-grey crystalline limestone and argillite, containing veins of quartz and specks of iron pyrites. Similar alternations are exposed in other brooks of this interesting region.

In the clearings to the eastward of Dallas Brook, behind the house of Mr. Norman McKinnon, layered felsite, limestone and slate are met with, whilst on the top of the hill limestone occurs, and further back, syenite, displaying a curious admixture of finely foliated gneiss. In some examples the syenite begins abruptly, as if cutting vein-like across the strike of the gneiss; in others the transition from syenite to gneiss is gradual. As at George River, the gneiss is associated with large masses of white quartzite. On a wood road where it crosses a small branch of Dallas Brook is a massive felsite like that of River Denys, whilst above the road the brook exposes a light-grey, pearly, twisted, quartz-veined slate. Pieces of coherent sandstone are also found in this vicinity but belong of course to a higher formation. On the same wood road a graphitic limestone forms a number of funnel-shaped pits, and gra- **Graphite.**
phitic slates are not uncommon in other areas of these rocks.

In the brook north of Dallas Brook bluish calcareo-felspathic slate appears below the bridge. Above it, vertically, light-greenish slates, the softer varieties cleaving into small pieces, strike S. 63° W. Higher still, a rusty-weathering mixture of compact quartz, felspar and calcspar, the first two predominating, dips south at a high angle and is succeeded by a bluish, fine, crystalline limestone which has been quarried. This contains large masses of white calcspar, which shine **Quarry.**
like burnished silver in the sun, in bright contrast with the dull lustre of the limestone. One branch of this brook comes from a spring over- **Spring.**
shadowed by a large beech tree and immediately beneath the syenite hill. Higher up in the main branch, grey and reddish syenite, the joints of which run up stream and across, passes into compact felsite, quartz-felsite and quartzite, rusty on the surface, cut by small veins of calcspar and resembling certain Boisdale rocks. With these are asso- **Graphitic slates mistaken for coal.**
ciated soft, friable, graphitic slates, dipping down stream at a high

angle, which have been mistaken for coal. Marble and diorite are found nearer the fork of the brook from the spring, and on the neighboring hills an amygdaloid with whitish soft spots is followed, near the syenite, by quartz-felsite. In other brooks flowing into West Bay from this outlier, contorted, layered limestone is interstratified with dark splintery felsite of varying color, texture and purity.

Amygdaloid.

Grey soft granite occupies the shore of West Bay near the church, but in the fields are many huge blocks of marble. Between two bands of compact felsite is an outcrop of bluish and greenish botryoidal felsite, veined with white crystalline quartz, waving and shaly, with serpentinous matter in some of the joints, which gives the rock a soapy feel. In one place it is so contorted as to form a series of small synclines and anticlines not more than an inch and a half wide at their base. Whitish and bluish-grey marble is exposed in many quarries in the fields; and near the church a graphitic limestone has been burned.

Contorted beds.

Graphitic limestone.

Campbell Brook.

Succeeding the syenite in the branch of Campbell Brook that flows from Donald McMillan's on the track to River Denys, are the following strata in order as they are met on descending the brook:

Talc-granite.

1. A coarse granular mixture of quartz, felspar and soft, light-canary-colored talc, from among which the particles of quartz can easily be cut. Lower down the brook this passes into a nearly pure quartzite, the grains of which cohere so strongly that it is only on weathered surfaces that the granular structure becomes evident.
2. Pyritous limestone-breccia.
3. Obscurely granular calcareous rock and whitish and bluish crystalline limestone with spots of clay.
4. A great variety of calcareous talcose and argillaceous shale or slate, dipping about S. 20° W., nearly vertically.

In a branch of this brook running from the road nearer River Denys, a coarse and fine, friable talc-granite, with white silvery mica, is associated with an impure, rusty, compact felsite followed by syenite cut by a lenticular, trap-like dyke, succeeded in turn by bluish-grey, pure, fine limestone and whitish pyritous, rusty-weathering, coarse limestone.

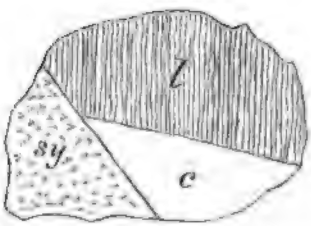
Gneiss and slates.

Between Kenneth Campbell's and the shore is a fine grey granite often twisted and gneissic. Something like a passage towards the shaly and felsitic rocks is often observed in the gneiss. At another outcrop in the vicinity, limestone is succeeded by a cliff of syenite and porphyritic diorite in contact with fine mica-schist or gneiss. Gneiss, mica-schist and quartzite follow the eastern boundary of this outlier behind Alexander McDonald's (Wild Sandy), the gneiss containing small veins of coarse syenite, and the syenite, fragments of gneiss. Further up, other patches of whitish crystalline limestone appear, some beds of

which are covered on the surface with large knobs of light-greenish and white serpentine; but the hills are composed mainly of syenite. The gneiss dips or strikes into the syenite veins as the case may be, but the contact of syenite with limestone was not here seen. Serpentine-limestone.

An imperfectly bedded, rough gneiss occurs on the hills behind Christopher Campbell's, syenite and crystalline limestone being also in the neighborhood. Another outlier is seen on the shore of Sydenham Lake to the northward. Sydenham Lake.

On the left bank of the Church Brook syenite is exposed for some distance above the shore road, succeeded by crystalline limestone intermixed with compact porphyritic felsite or quartz-felsite, like that of Benacadie Pond (Report for 1876-77, p. 408), and perhaps volcanic. In one place the syenite and limestone show an irregular contact. In a mass imbedded in the ground the calc-schist (*l*) seems to strike into Church Brook.



a syenite (*sy*) or in other words to be cut obliquely across the bedding by the syenite, the rock at (*c*) being concealed. If the mass is in place, as seems likely, the schist forms a boat-shaped outcrop between syenite on the north, south and east sides. Similar contacts are found on the large scale, and masses of syenite, gneiss and mica-schist are everywhere in the neighborhood associated with coarse, crumpled limestone.

The small outlier at Rory McLeod's quarry is worthy of notice, as being the first marble wrought by Mr. Brown. Here the relation of the syenite to the marble is well seen. Syenite everywhere adjoins the latter and seems in places to pass unconformably beneath it. The line of contact is very irregular, the limestone running in long tongues into the syenite. The syenite may be intrusive, but the absence of veins or dykes in the limestone seems to contradict this supposition. Or the limestone may fill deep, irregular hollows in the syenite, to which, however, the frequent vertical nature of the contact might be considered as opposed. Unlike the crystalline limestone elsewhere, the whole mass is homogeneous, not shaly nor even clearly bedded; it has been quarried to some depth and is white and good. McLeod's quarry.

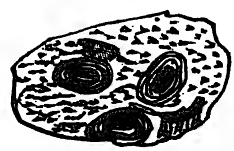
Marble Mountain.

The shore of the Bras d'Or Lake, from Marble Mountain westward, is low and the beach is covered with blocks, chiefly of coarse syenite or granite, probably sometimes in situ. Then come crumbling banks of rusty, compact felsite, weathering to clay, and bluish-grey and greenish argillaceous shales or slates like those frequently associated with the George River limestone, mixed with felsite, quartzite and limestone, in thin contorted layers. The whole series is like that of River Denys, hereafter to be described. The relation of the syenitic rocks to the limestone is interesting. In one instance a few bands of fine gneiss traverse a large block of coarse syenite, while a little further west flaggy and shaly limestone with a somewhat jumbled dip is underlaid by dark blue argillaceous slates. On the road in the vicinity syenite is in place, so that these strata seem to fringe the syenite like the cambrian rocks at Eskasoni. (Report for 1876-7, p. 428.) Still further west a compact, rusty white quartzite, passing into dirty calcareous rock and into a cream-yellow mixture of quartz, felspar and limestone, like that found at Queensville and Craignish, is on the shore, blocks of limestone lying along the waterline; and this with felsite forms a rocky shore.

Marble Mountain.

Foliated rocks.

The upper part of the steep brook immediately south of the post-office at Marble Mountain is occupied by grey coarse syenite and granite. Near the road, bluish-grey, graphitic crystalline limestone has been largely quarried. Just above the limestone, on the hill side, a curious block was seen among others of coarse syenite, consist-



ing of a coarse syenite in which three pieces of greenish fine diorite and gneiss lie like pebbles in a conglomerate. Around them the syenite is finer and foliated, as well as in other parts where they do not occur. This foliation does not completely surround the diorite and the transition from it to the syenite in two cases is abrupt. Below the road, limestone is in high cliffs, succeeded near the shore by layered, greenish and grey, calcareous and felsitic rocks, greatly broken. The limestone near Marble Mountain dips sometimes northerly, sometimes southerly.

Rocks at the marble quarry.

It has been already described in the Report for 1877-78, p. 30 F., but has since been carefully traced and the different outcrops and workings marked on the map so as to show the irregular manner in which the limestone and syenite are associated. The tunnels and pits display the

character of the limestone. The yellowish crumbling rock referred to, p. 31 F., at the Grand quarry, consists of layers of limestone, rusty clay and soft, spotted, soapy rock, yielding easily to the knife.

On the shore north of Marble Mountain, a greenish-grey coarse syenite or talcose diorite, with very little quartz, is seen to pass into a dark rock, containing, besides hornblende, only a few specks of felspar, and finer than the syenite into which it again passes. It is in close proximity to a very coarse, greenish and whitish, spotted mixture of felspar and hornblende, with scales of mica. This gives place to greenish-grey contorted gneiss and massive, foliated rocks, in which bedding and jointing may easily be confounded. A thick bed of crystalline limestone crops out on the shore beyond.

Near a small lake on a branch of McKenzie Brook, and again below the lake, are other exposures of crystalline limestone, surrounded on all sides by syenite. **McKenzie Brook.**

A cave three feet high and ten square occurs in another outlier of bluish-grey limestone, which has been quarried to a small extent by Squire McDonald, west of the track from Marble Mountain to McKenzie Creek. The dip is S. 50° W. < 25°, but irregular. Syenite is in place to the eastward. In the small brooks near Squire McDonald's, on the shore, greenish laminated felsite, jointed, and dipping S. 70° E. < 80, or grey, compact and massive, is associated with light bluish-grey, granular, pyritous diorite and grey, crystalline, imperfect syenite or felsite. Between this and the brook at Little Harbor post-office, outcrops of crystalline limestone also appear. **Cave and quarry.**

In Squire McDonald's millbrook, the first rock seen above the road is a compact felsite, striking about west vertically, succeeded by grey compact quartzite and quartz-felsite, dipping south-easterly. This is followed by bluish-grey, fine, layered felsite, hornblende-schist and quartz-felsite; and these by hornblende-schist, splintery schistose quartzite and mixed rocks, micaceous and sometimes resembling the diorite about Chisholm's mill, River Denys. Mixed gneissic and granitic rocks follow; then very coarse syenite. After a long interval of syenite, bluish-grey and whitish crystalline limestone, perhaps continuous with that in which the cave occurs, is met with at a minute pond at the head of one branch of this brook. In the other branch all the outcrops seen were of syenite. **McDonald's millbrook.**

Near Little Harbor, crystalline limestone is exposed in many of the fields, as indicated on the map. Nearly half a mile south-east of Little Harbor, on the shore, is a cliff, about ten feet high, of crystalline limestone and rusty, jointed breccia, the fragments being apparently of bluish-grey crystalline limestone, with a few of grey felsite. The dip **Little Harbor.** **Limestone-breccia.**

is greatly contorted. The breccia runs into limestone, and at the north end of the outcrop is a bluish-grey hematitic, jointed felsite, and dark bluish-grey, graphitic, argillaceous rock.

Crystalline Limestone of the Craignish Hills.—Turning now from North Mountain, we may enumerate the most important points in connection with the crystalline limestone and associated strata of the Craignish Hills.

Queensville.

The most southerly of the outliers of these hills is west of the Victoria road, and between Queensville and McMaster Brooks. It consists of bluish, semi-crystalline, quartzose limestone, associated with contorted, dioritic shale, seamed with a dark-grey pearly mineral and alternating with banded, contorted felsites; succeeded by coarse red syenite, banded felsite and bluish and whitish crystalline limestone, veined with white calcite. It has been used for lime, but is said to be hard to burn. Two other bands lie to the north-westward of this, at Queensville.

Queensville Brook.

Underlying the coherent grits, argillites and conglomerates of Queensville Brook is a series of obscure rocks, probably mixed with volcanic matter. They comprise the following strata, in the order seen on ascending the brook:

1. Dark steel-grey hornblendic felsite, very compact, and with greatly contorted bedding.
2. Quartzite in bands, dark-grey, flesh-red, hard and compact.
3. Dark-grey, pearly, argillaceous shale, greatly contorted.
4. Alternations of argillites and felsites.
5. Dark-grey calcareous rock, fine-grained or compact, passing into pearly, calcareous argillite, presenting a fantastically contorted appearance on the exterior. Blotches of white quartz.
6. Hornblendic felsite or diorite, and calcareous quartzite, sometimes finely laminated, talcose and slaty. The diorite is probably intrusive.
7. Thick-bedded felsite, streaked with hematite.
8. Reddish coarse syenite.

North of the brook a band of limestone is met with on the road, and occasional exposures are seen on the south bank. Higher up, near the east branch of this brook, coarse syenite is in contact with bluish contorted crystalline limestone, often containing an admixture of quartz and felspar, succeeded by diorite and brownish-white semi-crystalline quartzite, seamed with calcite. The limestone is shown to belong to a series overlying the syenite by its occurrence in the low hills adjoining the brook, whereas the brook bed is of syenite. Some of the associated rocks may be of volcanic origin, and the diorite dykes which cut the syenite in this district are probably the same as those which penetrate and affect the calcites to a much greater degree. The passage from this series to the coherent devonian grits is abrupt, and

Superposition of the limestone.

the latter appear to contain pebbles of the former. On the General Line road is a limestone intersected by white quartz, which runs in irregular gash veins, or forms a large part of a mixed rock. Quartz veins.

Between the source of Lamey Brook and the Northwest Arm of River Inhabitants, a mass of white and light-reddish quartzo-felspathic grit has been metamorphosed into a compact and fine-grained, seldom coarse quartzite, full of quartz veins. This is accompanied by reddish-grey, porphyritic, fragmentary felsite, and knobs of grey compact felsite. The Cape Porcupine grit is the nearest ally of this quartzite, which in texture resembles the jasper-conglomerate of Lake Huron. It is certainly not an altered form of the conglomerate and grit of the lower part of the brook. Both here and at Cape Porcupine, the felsite may be an igneous rock (the apparent lines of bedding at Cape Porcupine being like those of a furnace-slag). It has been clearly shown that the syenite of the cape is older than the conglomerate and grit, which are the same on both sides of the strait; but that it is associated with the felsite and quartzite as part of the same series, is not so clear. One might be laurentian the other huronian, or an upper portion of the laurentian series. Lamey Brook quartzite. Origin of the felsite.

Another of the curious mixtures of quartz, felsite and calcite, so characteristic of this formation, is found in another outlier at Queensville, with a band of white and grey, crystalline, calc-veined limestone. It is bluish-white, reddish, mottled and semi-crystalline, cut by dykes or irregular intermixtures of dark-green diorite, and surrounded by syenite and felsite.

On the hills behind Craignish several doubtful outcrops of limited extent are met with, and blocks of limestone abound. No other outcrops are known south of Glendale, where this formation again appears and stretches to Whycocomagh, presenting a much greater variety of rocks than at any of the other localities. Fine exposures occur in McPherson Brook, above River Inhabitants road, as follows: Craignish. Glendale.

1. Red and grey, coarse, pyritous syenite, dipping apparently in the same direction as the succeeding rocks. Strike N. 70° W.
2. Dark-grey and pure white crystalline limestone, containing bands of diorite and crystals of calcspar, and associated with light yellowish-green quartzose rock, containing small masses of quartz, and passing into dark-grey quartzo-felspathic rock, coherent and compact. McPherson Brook limestone, felsite, and syenite.
3. Steel-grey hornblendic quartzite, red and grey syenite, and hornblendic felsite, seamed with crystalline limestone, forming the western boundary of the limestone, and the same as the syenite of the other wall.
4. Alternations of syenite and limestone, the strike changing, higher up the brook, to north-west. The contact in the brook shows blocks lying against a bed of coarse syenite, the syenite being jagged and jointed. Higher up, the limestone strikes N. 25° W.

5. Dark-green felsite, underlaid by limestone.
6. Syenite, passing into yellowish and red, spotted, pyritous felsite, then back again into coarse greenish syenite, this into crystalline limestone, and then into coherent, semi-crystalline, fine-grained felsite. Some of the limestone is colored a brilliant green on the surface. The rocks are roughly mixed in patches, having no definite arrangement.
7. After an interval, red syenite strikes N. 75° W., and is followed by dark, fine-grained felsite, holding quartz, hornblende and iron pyrites.
8. Limestone, felsite and syenite are occasionally seen higher up.

After a long period of syenite, just below the road to Long Point the brook falls over dark and light-grey crystalline limestone, flanked by syenite and passing into sea-green felsite, together with light and dark-brown, compact, coherent quartzite, striking about N. 25° W. Near a fork of the brook is an exposure of bluish-grey and white crystalline limestone. Above the road is a dark greenish-grey diorite, then red syenite, and above it bluish-grey banded calcite; followed by very fine-grained red syenite and dark-grey felsite, passing into quartz-hornblende rock, sea-green felsite, or yellowish-white, compact, banded, waving limestone, striking N. 60° W. The contact of the rocks appears to be somewhat sinuous, but the faces are even, not jagged. Other outcrops which occur on the road present no features of interest.

Glendale Brook. In the various feeders of Glendale Brook, east of River Inhabitants road, crystalline and semi-crystalline, shaly, often impure limestone of whitish, grey and other colors, in places stained bright-green, dips as shown on the map. Sometimes it consists of a mixture of quartz, with a little limestone and grains of pyrites, and seems to be intimately associated with a coarse diorite containing a few grains of quartz. This runs into grey quartz-felsite and friable felsite, containing serpentine in the joints. Underlying the carboniferous rocks above the post-office, is a bluish-grey and purple quartz-felsite, with hematite in the joints, associated with a rather impure, rusty, hard limestone, stained with hematite, and containing small veins of calcspar. Besides the limestone there belong to this series in the region, a dark bluish-grey, or black, graphitic argillaceous rock, with serpentine in the joints, and a quartz-felsite or quartzite. A passage is often observed of one of these rocks into the other. The dips observed are recorded on the map.

Graham River gneiss and limestone. Near the source of Graham River, and a short distance above the bridge on the old River Denys road, is a gneissic quartz-felsite, jointed, and dipping about N. 65° E. $<$ 45°. On the right bank, for at least a hundred yards above the bridge, banded calcite occurs, the brook perhaps forming its western boundary. But syenite is in place both

above and below the bridge, and the outlier cannot be extensive. The brook is wild, rocky and full of cascades, running between steep banks and forming a prominent feature in the country. In one of its tributaries from the right bank, a whitish and bluish-grey finely crystalline calcite, with canary-yellow spots, strikes N. 56° W., near the syenite, but more northerly higher up stream. Sometimes it is a compact, beautiful, ringing stone. Much chlorite and soapy matter occur irregularly, with some layers, and the whole rock is a mixed one, with a roughened, dirty, weathered surface. Occasionally it contains minute specks of iron pyrites, and sometimes shows an obscure oblique slaty cleavage. Some parts are coarsely saccharoidal. It is usually finely laminated, although the laminæ cohere so strongly as to give it a massive appearance. Higher up the brook banded calc-felsite occurs with a more calcareous rock, succeeded by milky quartzite and bluish, compact, felsitic, banded rock. Then limestone blocks, beyond which nothing appears in the brook.

Mixed rocks of River Denys road.

In the same neighborhood, and near the River Denys road, a group of mixed rocks of considerable interest occurs. Large blocks of a conglomerate, which might be carboniferous or a concretionary form of the limestone, are associated with others of epidotic rock and coarse coherent conglomerate, without limestone pebbles. The concretionary limestone is intimately mixed with quartz and felspar, and is massive like that of Arichat and Queensville. It may belong to a newer series, altered with the grits and conglomerates of the neighborhood. It has a striking resemblance to that found on the shore of the Bras d'Or Lake at Matheson's quarry, North Mountain. (Page 23 F.) But the grit blocks of the neighborhood are very different from it, and perhaps it is a volcanic mixture. At Queensville, as at Graham River, the limestone is associated with much altered grit and conglomerate, which may point to their common origin. That they may be altered carboniferous strata is not impossible; and in places they do not resemble the George River series. The limestone is said to be hard to burn. Blocks of very compact quartzite occur with it, as well as crystalline limestone mixed and veined with felsite.

Victoria road.

The last area of these rocks to be mentioned is that which extends from the neighborhood of Glendale along the Victoria road, to Whycocomagh. They are well displayed on the road from Glendale to River Denys chapel and the adjoining brooks; in the east and west branches of McLennan's millbrook, and in another brook south of River Denys cross-roads. In addition to the calcite, they consist here of dark-grey, laminated felsite, streaked and veined with quartz; fine-grained, coherent petrosilex, calc-veined, jointed, in thick and thin beds, with purple and green blotches; argillite, waving and contorted; granular diorite, containing large masses of white quartzite.

In the brook north of McLennan's mill, contorted and slickensided mica-schist, associated with semi-crystalline quartzite in layers of a quarter of an inch to an inch in thickness, and with petrosilex containing blotches of white quartz, underlies the carboniferous conglomerate. By the addition of silvery mica, the quartzite and petrosilex pass into mica-schists, often pearly, greatly waved and contorted. A seam of light-brownish micaceous quartzite, four inches thick, runs through the schists, some of which contain large flakes of golden mica and much hematite. Alternations of these rocks occur as far as the source of the brook.

Schistose rocks at River Denys chapel.

On the River Denys road, between the source of the South-west Mabou River and River Denys cross-roads, calcite and mica-schist are well displayed in a curiously broken country. At the top of the hill, near the chapel, branches of the South-west Mabou, Denys and Inhabitants Rivers take their rise, deepening rapidly in their several directions into beautiful glens. Springs are, as usual, abundant in the limestone.

Diogenes Brook.

In the west branch of Diogenes Brook, which flows from the chapel, greenish-grey jointed quartz-felsite is found, but below the road to Glencoe the brook loses itself beneath a cliff of crystalline limestone fifteen or twenty feet high, coming out again as a large spring several hundred yards distant. Near this spring, a grey and reddish quartzite forms a succession of falls; and below these falls is a mixed quartz-calcite, together with a yellowish and bluish-grey limestone, which appears in the tributary flowing from the spring. In this tributary, also, syenitic rock is associated with crystalline limestone; and for some distance down the united brook indefinite outcrops of felsite and argillaceous shale and calcite are found.

In a brook which flows to this one from the River Denys road, and not far above the junction, dark greenish, crumbling, dioritic and felsitic rocks, full of soft matter, partly calcareous, occur, with impure limestone, plainly bedded and mixed with granular and compact hematitic felsite and quartzite, and with thick-bedded, whitish, reddish and bluish limestone, containing streaks of soft greenish matter. These rocks continue as far as a fork of the brook, where red friable syenite is in place at a fall. They dip off this syenite to the eastward; but among them appears syenite of the same kind, with which they are either lenticularly interbedded, or which may be a transformed portion of the other rocks. The massive syenite of the fall may belong also to this series, or the impure limestones may be shallow water deposits on the older syenite. The line of junction at the fall is also that of strike. Above this fall, in the north branch of the brook, huge masses of limestone form an outcrop in the bank, resting apparently on a floor of compact, splintery felsite and quartz-felsite, as on the syenite at

Junction of limestone and syenite.

Queensville. Hematitic syenite succeeds, and extends to the road. In the south branch of this brook, soft, soapy, obscurely bedded rocks occur, near the road, followed lower down by compact, splintery felsite or petrosilex, with many large blotches of milky quartz. After this comes syenite. Then crystalline limestone occupies the right bank, the syenite being in the left bank and bed, the brook following a gorge between the two, and descending steeply at the same time. There is nothing to indicate the bedding of the limestone, which often comes in between a quartz-felsite and the syenite. It seems to be about eighteen feet thick, and looks like a great vein. Near the junction with the other brook is a dark, compact, friable felsite, breaking into minute pieces, every one of which is surrounded by films of calcspar. This distribution of the felsite, syenite and limestone resembles the condition of occurrence of the similar rocks in the main branch of River Denys, which will be again referred to.

In the same brook, at Colin Chisholm's mill, greenish and bluish slaty quartz-felsite dips obscurely up stream. In a tributary which enters from the north, above the dam, white compact quartzite appears, with massive quartzo-felspathic rock and bluish-grey, soft and hard, argillaceous and felsitic slate. One of these rocks appears to be a greatly altered quartzo-felspathic sandstone, interbedded with slaty argillite, breaking into pieces of every shape. Massive, reddish-white quartzite, very coherent and nearly compact, having the appearance of a grit so altered that the grains are well-nigh obliterated, is associated with very coherent, cream-colored and whitish quartzite and compact vitreous quartz in high falls, above which comes a bluish-grey, rusty-weathering, very pyritous, splintery quartzo-felspathic rock ; a dark, calcareous felsite; a flinty felsite or petrosilex, with softer, more or less argillaceous, bluish rocks. Roughly bedded felsitic, jointed rocks, with bands of different colors, and probably altered argillites, occur above a fork of the brook, in a series of cascades. They extend to the source of the brook, whereas in an adjoining stream, which flows to South-west Mabou, syenite alone is met with. In Diogenes Brook, not far above the feeder just described, is a cliff of whitish-spotted crystalline limestone, underlaid by greenish and reddish, **Quartzites.** friable, coarse syenite, dipping about N. $<$ 70°. Higher up come quartzites and a compact mixture of felsite and quartzite, also a cream-colored mixture of quartz and calcite. Ascending the next large feeder from the north, we come to a cliff of fine crystalline limestone, in thick beds, or massive and with blotches of white or colorless quartz, **Quartz veins.** up to a foot in length. It is generally whitish, with a tinge of yellow, but varies in color and texture. Among others is a bluish-grey variety, containing films of graphite and serpentine in the planes along which it

breaks. It is followed by a greenish-grey, compact, impure, pyritous limestone, underlaid by mixed rocks containing chlorite and pyrites, passing downward into a pyritous felsite. Grey, bluish-grey and whitish compact quartzite follows, massive or in thin layers, and often containing felspar. Syenite then intervenes, and continues to the branch of South-west Mabou, to the northward. For some distance the brook follows close along the syenite on the north, as this rock appears in several of the tiny streams from that side. In a branch of this brook which enters not far above the Victoria road, at Finlay McPhail's, greenish-grey calcareous felsite, impure limestone and quartzite run into and are interbedded with one another. Eastward from Diogenes Brook, a tiny stream crosses to the north side of River Denys road, which follows its glen to the cross-roads. Below the road this brook displays :—

Syenite.

Gneissic rocks of River Denys cross-roads.

1. Foliated gneiss.
2. Finely laminated mica-schist, with small veins of quartz, and full of silvery mica. Dip, N.W. < 16°, but greatly folded on the strike.
3. Masses of grey granite also appear among the foliated rocks. Small lenticular veins, sometimes six inches thick, of a somewhat oily quartz, bluish-grey and white, occur in the bedding, showing specks of iron pyrites.
4. Schists, passing into crumpled quartzites, including bands of light-colored and white, thin-bedded limestone, underlaid by a dark, compact mica-felsite.
5. Massive, yellowish-white, finely crystalline limestone.
6. Mica-schist, associated with reddish-grey quarternary granite, massive and cut by quartz veins. Sometimes the crystals of quartz and felspar in this granite are two inches in length. Shows no bedding.
7. Banded mixture of quartz and limestone resting upon the granite.
8. Less schistose, crumbling rocks, full of mica.
9. Foliated mica-schist, dipping N. 30° E. < 58°.
10. Grey and bluish-grey, finely crystalline hornblende rock or diorite, showing no bedding, yet perhaps, as well as the granite, bedded with the other rocks, because a limestone seems to dip regularly N.E. from it. Contains long, delicate crystals, perhaps of andalusite.
11. Crystalline limestone.
12. Light bluish-grey, somewhat massive quartzite, passing into mica-schist. In a small tributary from the north, very quartzose rocks, with masses and irregular veins of quartz, holding large flakes of mica, are followed by massive quaternary granite and quartz-mica rocks, with a north-easterly dip.
13. Light-blue and greenish-grey mica-schists, dipping S. 65° W. < 55°, quartz-veined, and full of crystalline mica, with a vein of light, compact calcite, the rocks in the vicinity of which are greatly contorted. An obscure, slaty cleavage. The dip is again north-easterly.
14. Thin bands of limestone, interstratified with thin-bedded quartzites, which contain no mica.

15. Similar quartzites, containing felspar, and occasionally mica, with many cross quartz veins. Some of these quartzites have been supposed to contain gold, and a quartz-mill was erected some years ago on this brook to crush them. Quartzites supposed to carry gold.
16. Quartzites, with fewer quartz veins, and more mica in very small specks, greatly broken by cross joints.
17. *Carboniferous conglomerate*, composed of pebbles of the foregoing strata.

In other small brooks near River Denys cross-roads, quartzite and mica-schist underlie the carboniferous rocks. In one of them is a compact granite, containing much mica, and breaking into small angular pieces, together with a breccia composed of pieces of this rock, with quartzite; also, greenish-grey, laminated argillites, with concretions; quartzite, with red patches of felsite and blotches of white quartz; red-banded and jointed micaceous quartzite, overlaid by the carboniferous conglomerate.

In a brook crossing the Victoria road, further north, near J. R. Morrison's, above the plaster and other carboniferous rocks, which are not well seen, come bluish grey felsite and argillite; grey, whitish and colorless, vitreous quartzites, massive or finely interlaminated with felsite, and resembling a half-formed gneiss; purplish, thin-bedded, greatly altered argillites; a massive mixture of fine felsite and quartzite. Argillites. Higher up are cliffs of greenish-grey, massive, nearly compact, porphyritic felsite, and grey, fine-grained, pyritous, calcareous and felsitic rock, weathering like a breccia, and mixed with impure crystalline limestone and fine porphyritic diorite. Felsite. Similar outcrops of layered rock occur in all the branches of this brook and others of the neighborhood.

McPhail Brook, the next important stream, exposes plaster for some distance, underlaid by felsitic rock, containing calcite, quartz and serpentine, and passing into altered argillite. McPhail Brook. These are associated higher up with crystalline and semi-crystalline limestone, containing felspar and quartz, in waving, contorted bands. Higher still, crystalline limestone is more abundant. The usual alternations and mixtures continue over great areas. Argillite-felsite. quartzite-felsite, limestone-felsite, all occur. The quartzites are often fantastically contorted, as well as the limestones and mixed rocks. The greater part of this brook rises from springs near the road to Glencoe, on which, also, many exposures of crystalline limestone were seen.

The next brook is the main branch of River Denys, which exhibits the following succession above the Victoria road, the rocks being much mixed:— River Denys.

1. Brown, coherent, fine-grained quartzite.
2. Red and greenish fine and coarse syenite.

3. Bluish-grey, fine crystalline limestone. The actual contact of the syenite is here seen.
4. Dark, bluish-grey, highly altered argillite and felsite, compact, jointed, broken, contorted; veined with quartz, calcspar and felspar; talcose in the joints. Its contact with the limestone is sinuous, and the two seem to be intermixed, and pass into each other. Thick or thin-bedded.
5. Diorite, limestone and quartzite.
6. Steel-grey quartzite and petrosilex, passing into finely laminated felsite.
7. Laminated quartzites, chiefly of greenish, grey and whitish colors, occupying a great distance in the brook above the first feeder.
8. Above the quartzites, in one of the branches, are laminated felsites, resembling the quartzites in color and texture, and mixed with or passing into pearly mica-schist. Innumerable details concerning such mixtures might be given, but would be of no use. The chief feature is that no great mass of limestone appears in the lower part of this brook and its branches, mixtures being very frequent.
9. Limestone and dark grey felsite. The former is often serpentinous.
10. Mixed rocks, with serpentine in the joints; sometimes epidotic.
11. Contorted mica-schist, passing into argillite, containing veins of quartz and calcspar.

Blue's mills.

Near the branch of this brook, which comes from springs near John McDonald's (Gray), mica-schist and pearly argillite, petrosilex and other rocks occur; and on the road from his house to Blue's mills, grey, slaty detritus prevails.

Mull River.

In a tributary of the Mull River, adjoining the source of the southern branch of the last-mentioned stream, similar rocks appear; argillite, quartzite, felsite and a mixed quartz-limestone being among the first seen on descending the brook. These are succeeded by a grey, coarse syenite, overlaid in tu rn by carboniferous strata of the Mull River valley.

Kewstoke and Skye Mountain.

Crystalline limestone, diorite, felsite and other rocks of the River Denys series are met with on the roads about Kewstoke and Skye Mountain. Near Judson's, a grey conglomerate, which extends towards Mabou, is unconformably underlaid by bluish laminated felsite or argillite. On the Victoria road, towards the head of Whycocomagh Bay, laminated felsite and quartz-felsite, compact and fine grained, have a northerly dip. Nearer the bay, blocks of limestone occur in the road, followed by mica-schist. The calcites of Whycocomagh have been carefully studied and described by Dr. Honeyman.*

Devonian (?) Metamorphic Rocks.

Extent.

Rocks similar to those described as devonian in the Report for 1877-78, page 16 F., are met with in Madame Island, occupy nearly the whole of Guysborough county between the Strait of Canso and Chedabucto Bay, and again appear on the north side of the strait, west

* Transactions of the Nova Scotian Institute of Natural Science.

of Plaster Cove, stretching thence north-westward towards River Inhabitants. Probably also part of the country between the Craignish felsites, and the shore is underlaid by this formation.

Unconformity of devonian and carboniferous strata.

Although the unconformity between those rocks and the carboniferous is less marked than that which exists between them and the precambrian series, there are several localities where it cannot be overlooked, as for example near Arichat, at Lennox Ferry and Guysborough Harbor, where the carboniferous rocks, little altered, come in contact with and contain pebbles of the metamorphic rocks. At Lennox Ferry a carboniferous conglomerate seems to hold pebbles of limestone as well as of quartzite, etc., so that unless these be concretionary, the limestone at the quarry may be regarded, as it was near St. Peters, as the highest devonian bed. But as it appears, also, to be equivalent to that of Arichat, and as this rests unconformably upon the underlying conglomerate, it is perhaps better to regard the limestone as the lowest carboniferous bed, altered by the volcanic rocks of St. Peters, which thus belong to lower carboniferous time.

Possibly more than one group.

Fossils.

Many or all of these strata may belong to an older period than the devonian. Dr. J. W. Dawson found in the strata of Rocky Bay, east of Arichat, specimens of a somewhat obscure species of Rhynchonella, which he would refer to the silurian formation, on the analogy of other parts of eastern Nova Scotia. Nor has the region been so well examined as to make it certain that several groups of rocks have not been included under this division. That there are more than one is rendered probable by the occurrence of numbers of pebbles of quartzite in the conglomerate of Arichat. These pebbles, it is true, may be cambrian, but are probably in part newer. This question can perhaps be settled by the fossils which occur in many parts of the district, although for the most part the rocks consist of shallow water deposits in which fossils are few and obscure.

Thickness.

The thickness of the strata is no doubt considerable, although greatly obscured by the changing dip, and the impenetrable nature of the country, which will not admit of close examination. Between Rocky Bay and Lennox Passage alone, there seems to be a vertical thickness of at least 10,000 feet, and other sections indicate no less. In general characters the formation is similar to that part of it which is developed about Loch Lomond and Grand River. The rocks, including the limestone, are for the most part greatly contorted, which is perhaps another reason for placing the latter at the summit of this formation, rather than at the base of the carboniferous; but a crumpled limestone is seen elsewhere, as on Boulardrie Island, where there can be no question of its age; besides, the overlying sandstones and shales near River Bourgeois are equally crumpled.

Devonian rocks of St. Peters.

Before proceeding to describe these rocks as they occur along the Strait of Canso, a few additional references to those east of St. Peters may not be out of place.

In Detter Brook, below the St. Peters road, good exposures of shale, sandstone and quartzite, with a variable dip, are followed, near the shore, by the limestone of McNab Cove. Between Lochside and McNab's Lake, the same slaty, blue limestone is in place, whereas in the neighboring barrens small pieces of reddish sandstone are met with. Similar red sandstones in many of the cultivated fields of the vicinity sometimes strikingly resemble carboniferous rocks. No physical feature marks the division between the supposed carboniferous outliers and the devonian, perhaps because the former lie in shallow, limited patches, protected by the latter; nor is it quite certain that the quartzite pebbles of the carboniferous conglomerate were derived from the devonian series. Yet there can be little doubt that we have here two unconformable groups, as already described.

Mistake in map for 1878.

To the eastward of the schoolhouse at Lochside, the soft red carboniferous rocks do not extend far, pieces of quartzite being in the road. This will lessen somewhat the supposed area of these rocks as shown near the margin of the map for 1878, before they had been so well studied. The limestone near the schoolhouse is that of River Tom and McNab Cove. It dips at a high angle.

Loch Lomond devonian and millstone grit formations.

On the McCuish road, between the lakes of the Loch Lomond chain and immediately beyond the mill, the rusty soil of the millstone grit begins, accompanied by blocks of grey, rusty-weathering, fine and coarse sandstone. The point to the south is a barren, covered with innumerable wintergreen plants. In places, blocks of very compact quartzite lead to the supposition that the country is underlaid by it. Along the shore of the next lake millstone grit is scattered in great abundance. On the road back to the Loch Lomond road from the church, the blocks of wrinkled, veined and slaty limestone, like that of River Tom, may unconformably overlie the quartzite of the point.

A cursory examination of these devonian and millstone grit strata where they approach so close together, might lead to the inference that the quartzite of the former was but a highly altered development of the latter. A closer study of the rock, however, apart from the stratigraphical relations, leaves the impression that the quartzites cannot be altered carboniferous sandstones, any more than the conglomerate of L'Ardoise is an altered form of that of the Bras d'Or Lake. It is not improbable that the unconformity of the various series at Loch Lomond is complicated by faults, the steep strike of the millstone grit along the East Bay Hills, and other facts lending countenance to this conclusion. About Black River, above Grand River bridge, and also

near Loch Cailean, quartz-veined quartzites are in places, with reddish, purplish and greenish slates and conglomerates. Blocks of carboniferous conglomerate occur, however, near the bridge, and on the Soldier Cove road is a probable outcrop of carboniferous rock. Loch Cailean.

The devonian rocks have been followed already from Loch Lomond to Jerome Point near St. Peters. Here they are cut off by the sea, to emerge again on Madame Island, where they are largely developed. On Cap le Rond, the nearest point, red and green, veined, slaty argillites dip N. 14° E. < 35°, and a short distance to the westward, a grey, quartz-veined felspathic sandstone, with patches of conglomerate forms reefs. At the head of Goulet Pond outcrops of white-weathering compact quartzo-felspathic sandstone are seen at intervals. Between the Goulet and Descousse the following descending section occurs, the dip being S. 33° E. < 10°: Madame Island. Goulet Pond.

	Feet.	Inches.
1. Green, pearly, argillaceous rock, with red blotches	8	0
2. Red, pearly, argillaceous rock	7	0
3. Green argillaceous shale	2	0
4. Red and green mottled argillaceous shale	13	0
5. Greenish and red, somewhat sandy, coherent rock	5	6
6. Greenish crumbling sandstone	1	6
7. Bluish-grey, flaggy sandstone	4	6
8. Grey quartzo-felspathic sandstone, in rough, jointed, often nodular beds	9	0
9. Greenish areno-argillaceous somewhat crumbling rock, with patches of red	5	6
10. Red argillaceous rock, with large green blotches	15	6
11. Red and green, nodular, arenaceous rocks, forming rounded protuberances on the reefs	18	6
12. Grey, compact, quartzo-felspathic sandstone, full of veins	2	6
13. Red and purple argillaceous rock with small green spots	8	6
14. Quartz-veined quartzite, with green blotches	25	0
15. Measures concealed; probably the same as 14	4	0
16. Quartzite like 14	19	0
17. Measures concealed	..	..
Total thickness	149	0

At Descousse, one of the largest villages of the island, grey, greenish and whitish-grey, white-weathering sandstone, breaking into small irregular, angular pieces, and like that of L'Ardoise, occurs east of the chapel and near the mouth of Descousse Brook. Further west this is associated with reddish, micaceous, argillaceous sandstone. In Poulament Brook, greenish, bluish and purplish, coherent, quartzo-felspathic sandstone and argillaceous shale are finely displayed. To the westward, on the shore, rocks are seldom exposed, but the plaster of Lennox Ferry has been traced to Benoit Creek, whence it probably passes to the Descousse. Poulament.

southward of Janvrin Island, or is thrown there by a fault, the rocks of this island being apparently the same as those seen on the shore between Hawkesbury and Port Hastings.

Glasgow Point. At the root of Glasgow Point the sandstones are very coherent, and perhaps of devonian age; and a short distance to the southward dark-grey agillaceous shales and quartzites in alternate layers dip S. 31° E. < 80°. The latter occur also in the road to Le Blanc Harbor, and on both sides of the Ruisseau. At the head of tidewater the dip is seaward at an angle of 20°. On the road to Benoit Creek quartzite barrens abound as far as Grand Lake, followed by somewhat better land, underlaid by dark shale, and quartzites like those mentioned above. The country towards the head of Martinique Cove is doubtful. Between Benoit Creek and Lac Sec, quartzite comes to the surface among the marshes and barrens through which the creek flows. About Lac Sec, ridges of conglomerate and sandstone are also abundant, resembling those seen near Shaw Lake on the Grandique road. Grand Lake, West Arichat, and the bays of the neighborhood, show the same rocks. The country from West Arichat to the lakes south of Grand Lake is, for the most part, devoid of trees, rocky or marshy, and chiefly occupied by white-weathering, nearly compact quartzo-felspathic sandstone or quartzite, like that of the Grand River barrens, purplish coarse conglomerate, and grey, coherent, pebbly grit. Near the village of West Arichat, white quartzite, dark-grey argillite, conglomerate and reddish, waving, calcareous, quartzose sandstone, with green spots exhibit a variable dip.

The Ruisseau.

Lac Sec.

West Arichat.

Creighton Island. On the eastern shore of Creighton Island reefs of grey quartzite alternate with others of indian-red or purple conglomerate, and purple and greenish, flaggy and shaly calc-veined sparkling sandstone and grit, passing into the conglomerate, with vugs lined with quartz-crystals. To the eastward of Picard Reef they are broken through by dark-green or bluish, finely crystalline, soft diorite, four feet wide and under, which runs in a general way with the bedding, but crosses at times from one layer to another. The conglomerate and quartzite are not materially altered by this intrusive rock, which is not unlike some of the rocks to the eastward of St. Peters. Nearer Picard Reef, a larger, black, trappean mass occurs on the beach. To the westward the following section is exposed:

Picard Reef.

	FEET.	INCHES
1. Grey nut- and egg-conglomerate	60	0
2. Bluish-grey fine argillaceous shale	4	0
3. Grey, sparkling, quartzose sandstone	40	0
Total thickness	104	0

A short distance further west, bluish-grey sandstone, grit and con-

glomerate accompany quartzite and bright-red shale. Near Arichat Head, finely laminated bluish-grey argillo-arenaceous shales and flags, full of small coaly impressions and pyritous nodules, in thin layers, waving and greatly contorted, appear to strike into the conglomerate with which they are in contact. They are about sixty feet thick, spotted with calcspar and jointed at irregular intervals both at right angles and obliquely to the bedding. It is probable that these correspond with the Arichat dark shales. **Arichat Head, dark shales.**

On the eastern Crid Island conglomerate caps a bluish and buff, bedded precambrian felsite, whereas on the western island conglomerate is the only rock found. **Crid Islands.**

At the Jerseyman Island lighthouse, a red and grey conglomerate runs into bands of red sandstone. To the westward, thick-bedded greenish-grey argillaceous sandstone, veined with calcspar and passing into red shaly sandstone, dips N. 2° E $<$ 20°. Large blocks of dark-bluish limestone are found among the boulders of the point. On the western point, a thick-bedded, light greenish-grey, jointed, quartzose sandstone contains numerous seams and patches of calcspar and passes in places into coarse grit and conglomerate. **Jerseyman Island.**

On Irish Point, north of Crid Islands, are red and light-green sandstone, conglomerate and grit, often calcareous, with light-grey and greenish limestone running into grit and fine conglomerate, and thin bands of black limestone, seamed with calcspar, dipping steeply eastward in waving beds. **Irish Point. Limestone.**

To the north and west of the felsite bands at Arichat, conglomerate is well exposed, and with quartzite forms the bold shores of the lakes of clear water south of Grand Lake. On the south side of the head of Arichat Harbor, light bluish-grey fine sandstone is succeeded in a high bank by bluish and blackish, polished, micaceous, graphitic shales, dipping about S. 25° E. $<$ 45°. These shales contain minute entomostracans and strike down the harbor in contorted, nearly vertical bedding. On the roads in the vicinity conglomerate crops out in mounds twenty-five or thirty feet high. It consists of pebbles of red, purple, grey and white quartzite, sandstone, argillite and felsite. At Ranteleau Point it contains large pebbles of Louisburg felsite, and is succeeded by grey, calcareous, flaggy, fine sandstone striking N. 75° E. vertically and often assuming the form of grey limestone of various degrees of purity, sometimes nodular, with calcspar veins. A little further east, copper-green or purplish conglomerate is again in place, including large blocks of quartz-felsite and quartzose sandstone or grit. This extends as far as Grosnez, where it dips N. 22° E. $<$ 30°. Quarter of a mile past Flat Point the dip is N. 18° E $<$ 45°, the greenish conglomerate forming a bold rocky coast on which the waves are lashed **Arichat dark shales. Fossils. Conglomerate. Ranteleau Point. Limestone. Grosnez.**

into foam and spring high into the air. Long valleys run parallel to the strike, some of them as inlets or minute fiords. In the first broken cove beyond, finer rocks are associated with the conglomerate, greenish, whitish and reddish sandstone or quartzite dipping N. 25° E. $<$ 60°; and similar rocks, with the addition of argillite, continue as far as Cabbage Cove, where the coast is lower, somewhat less rocky and has more beach.

Cabbage Cove.

Little Anse.

Near Little Anse, bright flesh-red felsite and granular quartz-felsite again appear from beneath the conglomerate which is almost wholly composed of their ruins. This conglomerate occupies the coast as far as Jersey Point; it is bluish and greenish-grey, occasionally reddish, very coherent, veined and blotched in every direction with calcspar: the quantity of calcspar being as remarkable as in many carboniferous conglomerates. It is associated with small and apparently lenticular patches of soft, veined, calcareous rock and grey compact quartzite.

Petitdegrat.

The mossy and rocky barrens of the greater part of Petitdegrat Island are occupied by these strata. On the shore near Big Arrow, red, purple and greenish, calcareous, fine, coherent rocks are found with greenish and grey, veined, felspathic and quartzo-felspathic sandstone and conglomerate.

Rocky Bay.

The interesting deposits of Rocky Bay alone remain to be noticed. North of the outlet of Shaw Lake, at the shore, coherent grit and fine conglomerate, with thin, irregular veins of quartz, dip steeply N. 25° W., and are followed by purple, greenish and grey grits, indian-red, flaggy and shaly, arenaceous, coherent, harsh, jointed, cleft and waving rocks, like those of Salmon Creek and L'Ardoise (Report for 1877-8, p. 17 F), sometimes friable and pearly, with quartz in films, blotches, and veins which contain much chlorite. The different varieties seem to be confusedly mixed, the sandstone passing on one hand into fine granular quartzite and on the other into compact sandstone, often almost replaced in the bedding and across it by veins of quartz and calcspar. The slates break into their component interlocking plates, giving the beds a waved appearance. They do not seem to contain fossils. Quartzose and felspathic rocks, usually very compact, prevail to the village of Rocky Bay and on the road to Petitnez, some of the finer beds yielding carbonized plants.

Fossils.

South of the outlet of Shaw Lake a good section of these rocks is presented, in descending order, as follows:—

SECTION OF DEVONIAN ROCKS AT ROCKY BAY.

	FEET.	INCHES.
1. Conglomerate, greenish-grey and reddish, rough, and similar to that of L'Ardoise; containing pebbles of every size in a paste of different kinds, but chiefly of fine grit composed		

	Feet.	Inches.	
of felsite and quartz; often rusty, with a purplish or reddish tinge pervading the cleavage planes. The pebbles are of quartzose sandstone and quartzite—derived from rocks like those of Framboise and Fourchu, but perhaps silurian—together with granular and compact, felsitic and syenitic rocks of the Louisburg series. Dip N. 29° W. < 47°	22	9	
2. Grey and bluish-grey, often flaggy, quartzo-felspathic, micaceous, rippled shales, seamed in all directions with films of calcspar, and containing broken fragments of *Cordaites*	7	0	Plants.
3. Greenish argillo-arenaceous shale, rippled and containing *Cordaites*; full of calcspar streaks and veins which run across the bedding and in it, and also in the joints and cleavage planes. This passes downwards into coherent pebbly grit. In places rusty on the surface and greatly waved. Dip N. 38° W. < 47°	11	9	Calcspar veins.
4. Indian-red and purple, argillaceous, flaggy sandstone, with green calcareous blotches and beds	13	6	
5. Light-green argillaceous shale	0	2	
6. Light-green argillo-arenaceous shale	1	4	
7. Argillaceous, shaly, crumbling rock	0	8	
8. Greenish, argillaceous, flaggy sandstone	1	3	
9. Indian-red and purple, green-spotted argillo-arenaceous rock	13	6	
10. Argillo-arenaceous flaggy sandstone. All are greatly waved but not sufficiently to interrupt the continuity of the bands	1	4	
11. Measures concealed	4	0	
12. Light greenish-grey, calcareous, argillaceous and arenaceous shale, containing plants in great profusion; serpentine on some surfaces; seamed with films of calcspar. Dip N. 39° W. < 52°	16	0	Plants.
13. Grey and blackish-grey, shaly, argillo-arenaceous rocks, full of plants	36	0	
14. Light-grey, brown-weathering sandstone, passing into fine-grained conglomerate	14	0	
15. Indian-red argillaceous sandstone. In the red rocks no plants were seen	18	0	
16. Measures concealed. Dip N. 19° W. < 34°	38	0	
17. Dark-grey argillaceous shale, full of plants; calcspar veins. A calcareous concretion two inches in diameter	5	6	Plants.
18. Light greenish-grey, flaggy, argillaceous sandstone. Plants	7	0	
19. Light-grey sandstone, passing into conglomerate	4	6	
20. Red, purple and green sandstone	1	10	
21. Red and green, crumbling, shaly sandstone	2	6	
22. Red, purple and green sandstone	0	8	
23. Red and green, crumbling, argillaceous shale	1	9	
24. Bright green argillaceous shale	4	0	
25. Light greenish-grey, flaggy, argillaceous sandstone, with plants in great profusion. Becomes thick-bedded and green below	5	1	

	Feet.	Inches.
26. Purple and green, mottled, argillaceous sandstone	1	8
27. Purple, spotted, argillaceous sandstone, shaly and thick-bedded, seamed with calcspar	9	0
28. Greenish-grey, argillaceous sandstone, full of calcspar	2	2
29. Grey clay and sandstone in alternate layers	3	6
30. Light-grey, fine-grained conglomerate	1	8
31. Argillaceous shale passing into sandstone	6	6
32. Light-grey grit, with plants. Not all seen	1	6
33. Measures concealed. Dip N. 23° W. $<$ 42°	8	0
34. Bluish argillaceous shale with large concretions	2	0
35. Dark bluish-grey, waving sandstone, with occasional patches of conglomerate; seamed with calcspar	20	0
36. Lighter sandstone passing into shale, pebbly, waving, sometimes brown	7	0
Fucoids. 37. Red, purple and green, rippled, argillaceous, shaly sandstone, with doubtful markings of fucoids	7	0
38. Bright-green shaly argillite	1	6
39. Red and purple calcareous sandstone, shaly in part	3	6
40. Dark grey and blue, flaggy and shaly, argillaceous sandstone, seamed with calcite. Impressions of broken plants	20	0
41. Greenish-grey conglomerate, passing into flaggy sandstone	6	0
42. Conglomerate, passing into and alternating with sandstone and shale, of red, green, purple and other colors. Thickness indefinite	..	..
43. Measures concealed by a sand beach, beyond which felsite is exposed near Fourgier Point, unconformably overlaid by rocks similar to those just described	..	..
Total thickness	332	4

Rocky Islets. The Rocky Islets are of conglomerate, which at the eastern end of the main islet dips N. $<$ 60°. At the western end, the dip is N. 4° W. $<$ 45°. Although slightly bent in places, the strike is always well defined, running along the islets.

Guysborough Devonian Rocks.—The stratigraphical continuity of the devonian strata of Madame Island is interrupted by Janvrin Island and the waters of Chedabucto Bay, but they reappear on the shores of Guysborough county opposite. Immediately south of the pond, at Eddy or Sand Point, red and green, mottled, argillo-arenaceous, compact rock dips N. 19° W. $<$ 45°, underlaid further south by bluish and greenish argillaceous shale, with coherent, jointed, micaceous, arenaceous shale and flaggy sandstone, full of ironstone nodules and blotches and small veins of calcspar, alternating with thick bands of bright red shale. South of Red Head, grey, fine, compact, quartzo-felspathic sandstone occurs, succeeded, on the point north of Cape Argos, by

Eddy or Sand Point.

grey, reddish and purplish conglomerate, somewhat friable, having a northerly, moderate dip. These rocks are not unlike the finer beds of Madame Island, but the proportion of fine to coarse sediments is here reversed. On the shore, westward from Eddy Point, bluish and grey, and mottled red and green, ripple-marked, argillaceous shale, with more coherent, thicker, beautifully waved, arenaceous layers, form steep cliffs, striking parallel to the water for a great distance. In a brook flowing from a lake, about a mile and a quarter west of Eddy Point, bright indian-red and greyish argillite is exposed on and above the shore road. At the mouth of Melford Creek are reddish, grey and rusty, fine sandstones, in thick beds, followed a short distance above the road by grey, white-weathering, quartz-veined, quartzose sandstone, passing into conglomerate, and associated with indian-red sandstone and argillite. The dip is variable. Several falls, ranging from eighteen or twenty feet downward, occur in the grey sandstone. In the north branch, bluish-grey felspathic shale dips westerly, at an angle of 50°, above the bridge, on the Middletown road In the east branch, grey argillaceous sandstone, with indian-red and bluish, shaly argillite, form cascades of considerable beauty. Near the confluence of the north and south branches are other falls over hard, grey quartzose, argillaceous sandstone with variable dip. In the south branch, similar rocks prevail, and near the Middletown road indian-red argillaceous shale dips N. 70° W. **Melford Creek.**

Greenish-grey quartzose sandstone and argillaceous shale, the latter marked with vegetable impressions and a shell, like *Modiola*, occur with conglomerate, grit and quartzite between Melford and Steep Creeks. Above the falls of Byers Brook, near the road, the following strata are cut, with a steep easterly dip:— **Fossils.** **Byers Brook.**

1. Grey, coherent, quartso-felspathic, coarse grit and conglomerate, with patches of greenish and purplish, fine, micaceous sandstone, streaked with calcspar, and broken by joints.
2. Purplish, fine, micaceous, argillaceous rock and reddish sandstone.
3. Grey and whitish, sparkling, coherent, quartzo-felspathic sandstone and grit, with large blotches of milky quartz. Like the rocks of the Grand River barrens and Arichat.
4. Purple, coarse sandstone, grit and conglomerate, forming falls.

At the source of the brook a wood-road runs through marshy spruce-land, underlaid by rocks like those of Lynch Creek near St. Peters. Rocky pasture-land, wet spruce-land and mossy barrens extend back some distance from the shore, and between the wood-road and Steep Creek, long, parallel ridges of conglomerate form a country scarcely less barren than Petitdegrat.

Steep Creek.

In Steep Creek and on the roads of the neighborhood similar exposures occur. The Middletown road, near Melford, ascends a hill of white-weathering, quartzo-felspathic grit, conglomerate, and greenish, coherent, somewhat pearly, splintery, argillaceous shale, which are seen at intervals as far as Middletown. Between this settlement and Birchtown, dry, rocky barrens exhibit blocks of conglomerate and sandstone, precisely like those of the barrens of Grand River and Loch Lomond. Thick beds of these rocks are seen in the beds of all the streams, and will be more fully described hereafter.

Middletown road.

Pirate Harbor.

The East Pirate Harbor Brook, a mountain stream, affords good exposures in the following descending order, above the shore road :—

1. Grey, fine, very coherent, quartso-felspathic sandstone, like that at the foot of Loch Lomond.
2. Grey, fine, micaceous sandstone, soft and shaly, or hard and splintery, greatly jointed.
3. Grey, fine sandstone and grit, weathering light-red and purple. Much calcspar in the joints. The coarser grit seems wholly composed of syenite *debris*.
4. Purple and greenish, sometimes mottled, fine and coarse rocks, in a gorge.
5. Greenish-grey rocks, of every degree of texture, veined with quartz. A narrow, beautiful, woody valley, contained by high, green banks.
6. Various coherent rocks, chiefly more or less conglomeritic, continue for a great distance.
7. Greenish and grey slate and quartz-veined, quartzo-felspathic sandstone.

Parallel ridges, like those before described, of conglomerate, grit and sandstone, run along the shore between Pirate Harbor and Steep Creek, separated by small valleys. Some of the cliffs are mural; sometimes they run and rise on the bedding-planes. The clearings in the vicinity are exceedingly rocky, coherent blocks lying about in great profusion.

In the West Pirate Harbor Brook, light-bluish-grey felspathic sandstone is often present. Near the shore occurs a succession of beautiful falls over quartzite and sandstone, in flaggy or thick beds. Still nearer, grey sandstone and grit are associated with argillaceous shale and conglomerate. In the north branch, similar rocks give rise to falls of considerable height. As the hills on the south side of the Strait of Canso rise abruptly to a height of from two to six hundred feet, the brooks usually rush down in steep rapids, gorges and cliffs.

Limestone quarry.

At Pirate Harbor, a limestone, probably the same as that found at St. Peters and Plaster Cove, is underlaid by whitish, often shaly quartzo-felspathic sandstone. About a mile to the northward, at McLean's quarry, the limestone rises into a high cliff, and is succeeded towards the shore by plaster and soft rocks. Behind the limestone, and apparently dipping in the same direction—E. $< 50°$—is a bed of

grey, fine sandstone, underlaid by pebbly sandstone, grit and conglomerate, succeeded by dark-bluish micaceous slates, enclosing thin bands of sandstone. North of the brook, ledges of grey, fine conglomerate produce rocky pasture-land.

Wylde Cove flags.

At Wylde Cove is a fine, greenish sandstone, which might make good flags. On the road from this cove to the New Glasgow road, at a mill, grey, pebbly or conglomeritic grit, coherent, and composed of syenite detritus, or friable and reddish, veined with quartz, brings to mind certain rocks of Madame Island. On the New Glasgow road, near the fork, bluish-grey shales occur, which follow the road for a great distance. They are argillaceous, and include bands of light-grey, quartz-veined, quartzo-felspathic sandstone and grit, which may be examined in the adjoining brook. Further up this brook, grey, massive grit appears, accompanied by barrens, on which weathered blocks are everywhere present. The hardwood hill on the right bank displays cliffs of bluish-grey, somewhat crystalline limestone or impure clay-rock, in half-inch layers, weathering soft, and producing excellent soil. At the foot of the hill is a hay-marsh. On all the wood-roads in the neighborhood, and around Grant and Summers Lakes and their feeders, blocks or outcrops of quartz-veined, jointed, rough, felspathic sandstone and grit occur, thick-bedded or massive, occasionally passing into more argillaceous rock, the country being for the most part barren or covered with small spruce and uninhabited. Further west, on the New Glasgow road, quartzose sandstone is associated with greenish-grey, micaceous, jointed, finely laminated, slaty argillite, full of minute veins and blotches of milky quartz. Near a small settlement and post-office, greenish and bluish shaly rocks have a southerly dip.

Dyke on the line between Guysborough and Antigonish counties.

On the railway, and a short distance south of the county line a dark-green, calcareous diorite cuts bluish-grey, quartzo-felspathic, flaggy sandstone and splintery argillite. It is generally finely crystalline, with the grains of hornblende and felspar distinct, but like many of the Salmon Creek dykes, passes into compact felsite, and contains cubes of iron pyrites. The joints are coated with calcspar and a soft, chloritic mineral, and some of the planes are slickensided.

Contact of devonian and precambrian rocks.

At Auld Lake, the lowest rocks of this series are greenish-grey, fine, felspathic sandstone and grit, quartz-veined, and interstratified with conglomerate, forming rocky and often barren land, with cliffs and hills. Blocks of red syenite also occur along the road, rolled from the adjoining hill, which runs out to Cape Porcupine. In Auld Brook, a short distance above the mill, near the shore road, is a light-red quartzose conglomerate, the pebbles of which are quartzite, felsite

and reddish fine quartz-felsite. It weathers whitish-grey, and passes into quartzo-felspathic sandstone, quartzite or grit.

Cape Porcupine

In a brook at the south end of Cape Porcupine, not far above the road, bluish-grey, laminated, earthy, streaked limestone dips about N. 75° E. < 20°, succeeded immediately by high cliffs of dark-bluish-grey quartzo-felspathic sandstone or quartzite, nearly compact, dipping S. 50° W. < 75°, associated with softer, bluish-grey, fine, micaceous, jointed sandstone, slickensided, and full of joints, stained with calcspar. In the neighboring fields are fine, light-grey, quartz-veined grit and quartzite, with white-weathering, very coherent conglomerate, grit and argillite, rough, and veined with quartz, beneath which is the syenite of the hill.

North of the cable landing, at the north end of the felsite boss, the shore exposes fine, whitish and bluish-grey, flaggy and thick-bedded quartzo-felspathic sandstone and grit, sometimes soft, argillaceous and calcareous, but generally compact and coherent. These are unconformably underlaid by flesh-red, compact and granular felsite, quartz-felsite and syenite. The lowest beds of grit are very calcareous, and often obscurely nodular. In other cases syenite is overlaid by syenitic conglomerate and grit, with thin beds of argillaceous shale. Further north are bluish-grey and reddish, fine, argillaceous and sandy shales, like those of Rocky Bay, full of small, rounded, concretionary forms, with a calcareous spot in the centre, simulating coprolites or encrinites. Mica is abundant, and doubtful markings of plants are frequently seen. Rough cliffs of grit and finer rock often contain a great deal of calcspar; and some of the rocks are concretionary, and show obscure lines of cone in cone, or have the small. bright-green, calcareous spots so common in concretionary limestones. The concretions are often pure limestone, and the rock itself an impure limestone or strongly coherent marl. It is associated with fine, syenitic grit and splintery sandstone, sometimes arranged brick fashion by joints at right angles to the bedding.

Havre-au-Bouche.

On the shore, between Havre-au-Bouche and North Canso, rocks resembling those of Eddy Point are met with in the following descending order:—

1. Bluish-grey sandstone, with a tinge of red, compact, micaceous and felspathic, often passing into rippled and waving arenaceous shale, sometimes purplish and bright green, with a few thin calcspar veins.
2. Reddish, grey, bluish-grey and greenish argillaceous and arenaceous shales, full of broken plants. Traces of coaly matter, one or two obscure ferns, and a small, doubtful *Modiola*. Vugs of calcspar and quartz, and lenticular layers of bluish-grey limestone, in rolls six inches thick, or in layers of uniform thickness, which overlap one another. There are also bands, two

feet thick and downward, of grey, fine, coherent, calcareo-felspathic sandstone.

3. Crumpled and rippled, calcareous shales, with thin layers of calcareous sandstone. Some of the rocks weather into globular masses, but are otherwise like the rest.
4. The most important member of this section is a limestone, light-bluish-grey, flaggy and shaly, veined and drused with calcspar, crumpled, of every degree of purity, but seldom quite pure; highly bituminous, but seems to contain no fossils except obscure plants. About twenty-five feet of this limestone were seen. Perhaps it is a depauperated form of the plaster and limestone of Plaster Cove and Pirate Harbor, in which case the rocks just described will also be carboniferous. Beds of limestone seem often to change into gypsum, and the plaster reported to have been found in digging wells at Havre-au-Bouche, on the strike of this limestone, may be of this nature.
5. Greenish-grey and grey quartzo-felspathic, massive sandstone or quartzite, like that of Loch Lomond, full of veins of quartz and calcspar, underlies the limestone. It passes on the one hand into L'Ardoise conglomerate, and on the other into fine, dark-bluish, argillaceous rock, crumbling into long, narrow pieces, and containing lenticular masses of limestone.

Near the mouth of McDonald Brook is a dark-green, calc-veined trap in contact with dark-bluish quartz-felsite, very fine in texture, probably an altered quartzo-felspathic sandstone, but not well seen. Above the road this brook displays dark-grey argillaceous shale, compact, felspathic sandstone, and conglomerate, containing pebbles of red and white quartzite and felsite. Beyond the brook, towards the mouth of Archie Pond, are many outcrops of conglomerate, like that seen on the backlands roads up the rocky hills in the vicinity, associated with reddish and bluish shaly sandstone and conglomeritic grit. Trap of McDonald Brook.

The Guysborough road, near Pirate Harbor, passes over quartz-veined, white-weathering, often micaceous, quartzo-felspathic sandstone and shale, underlying rocky barrens, and interstratified with nut and egg-conglomerate, very like that of Arichat; and at Pirate Harbor these rocks form a steep, rocky hill. Around the Goose Harbor Lakes, on both sides of this road, similar rocks appear, crossed in every direction by a net-work of veins of milky quartz, with, in one place. an indian-red argillaceous shale. On the road from these lakes to Middletown, greenish quartzose grit is met with, as well as blocks of argillaceous shale and sandstone. At the outlet of the lakes, greenish quartzose sandstone dips N. 45° W. $<$ 53°. Beyond Clinton, grey and bluish, somewhat pearly, coherent. often papery, splintery shales, and massive bluish-grey, white-weathering quartzo-felspathic sandstones, form a country like the Grand River barrens. As usual, the sandstones are full of quartz-veins and blotches, and associated with nut and egg-conglomerate, containing pebbles of whitish quartzite and felsite. Pirate Harbor. Guysborough road.

Between Clinton and Boylston are occasional outcrops of greenish and purplish argillaceous shale and sandstone, as well as quartz-veined conglomerate. The road from Guysborough to Tracadie displays greenish coherent slates and quartz-veined quartzites.

Unconformable contact of devonian and carboniferous strata at Guysborough Harbor. On Guysborough Harbor, north of Star Point, rocks in general like those of the rest of the country—quartzo-felspathic sandstone and slate, pebbly and conglomeritic grit, grey, white-weathering sandstone, full of quartz—have a high, obscure, easterly dip. Many small quartz-vugs exhibit drusy crystals of quartz and chlorite. At Star Point, these rocks are overlaid by carboniferous strata, containing pebbles, evidently derived from them. Near Star Point, similar rocks are again unconformably overlaid by carboniferous conglomerate. On the road which runs eastward from this point there is a hill composed of white and grey-weathering, fine sandstone or quartzite, grit and conglomerate, resembling quartz-felsite or Louisburg breccia, for which they might be mistaken. They are full of veins and blotches of milky quartz, holding chlorite and grains of magnetic iron ore.

Near the carboniferous limestone of Guysborough Harbor is an outcrop of grey quartzose sandstone, grit and conglomerate. The conglomerate, like that of Arichat, coarse and fine, forms rocky hills about Marshall Point. In some places it resembles a quartz-felsite; in others it has large pebbles of red and grey syenite and felsite, and is veined by quartz, containing much chlorite. At Hadley Cove, near the mouth of Guysborough Harbor, are greenish-grey, quartz-veined, micaceous sandstones and shales, rather soft and crumbling, with purplish and greenish, mottled, hematitic, rippled sandstones, showing obscure fucoidal markings, and strongly resembling the rocks of McNab Cove and Rocky Bay. Some of the shales contain veins and blotches of calcspar, which often bursts asunder their planes of jointing and bedding, so as to give them the appearance of calcareous breccia or conglomerate. Similar rocks of the hardest and most coherent kind are present in all the roads and fields of the neighborhood.

Stewart Pond. A short distance west of Stewart Pond, shale and conglomerate surround a hill of trappean and felsitic rock. Nothing was seen to determine whether this is older or newer than the shales; but its composition leads to the strong presumption that it is a boss of precambrian rock.

Ores of iron and copper. On the shore, good exposures of the devonian rocks occur, in contorted cliffs, thirty feet high, holding large masses of iron ore. They comprise bluish, grey, greenish, purplish and reddish, shaly and thick-bedded, quartz-veined, fine, quartzo-felspathic sandstones or quartzites, with

Plants. blackened impressions of minute plants. Traces of hematite and green carbonate of copper occur in the joints, of which there are many, in quartz-veins and in thin sheets of quartz in the bedding planes.

These are precisely like the strata of Rocky Bay. The sandstones pass into grit and fine conglomerate, associated with shales full of beautiful veins of calcite of various colors, sometimes mixed with quartz. One banded vein, two feet or more in thickness, with interlocking crystals, chiefly of dog-tooth and calcspar, has a north and south trend, a high and variable dip, and many branches or side-veins. Another vein, three feet thick, is formed of large interlocking crystals of dog-tooth spar, sometimes an inch in diameter, with drusy cavities lined with the same mineral. Some of the veins, also, are brecciated or contain pieces of the enclosing rock. Calcite veins.

But nowhere can these strata be studied to better advantage than in the rivers that run in a southerly and south-easterly direction into Chedabucto Bay, all of which can be followed from the sea to their sources. Owing to the undulating nature of the beds, no estimate can at present be given of the thickness of the strata, which will nevertheless be described in a general way. It will be noticed, on reference to the map, that long stretches of the rivers run on the strike.

In Clam Harbor Lake, bluish-grey sandstones of the usual character are seen, and near the outlet are curiously knobbed and wrinkled by the water. The brook which flows from Sundown Lake forms a series of rapids and falls over soft argillaceous shale and grey conglomerate, composed of pebbles of syenite and felsite in a paste of fine quartzose grit. At the head of this lake, greenish, very hard, coherent sandstones, interstratified with greenish, fine shales, include masses of milky quartz. In Clam Harbor River, above Sundown Brook, greenish, coherent, vertical, felspathic shales or slates strike N. 6° W., and in the west branch similar rocks give rise to wild rapids. Nearer the Guysborough road, felspathic sandstones and shales, sometimes papery, contain blotches of milky quartz. Mossy marshes, reaches of still water bordered by roses, and wet fernland, interrupt the rocky rapids of the upper part of this river, but in many places it is more picturesque, the banks high, the bed clean and shingly, overshadowed by hardwood trees. Above the Middletown road, the prevailing rocks are bluish, greenish or bright-green, rough, pearly, slaty argillites, often greatly contorted, interstratified with thin layers of pyritous quartzo-felspathic sandstone. These often pass into hard, felspathic rock, with large veins and blotches of highly crystalline quartz, including chlorite, iron pyrites (which may have led to the search made in them for gold) and aggregations of quartz-crystals in small druses or large prism-pyramids; or wherever the slaty structure is obscure, into very evenly bedded shales. Just above Birchtown, a large colored settlement, they form a fall or series of falls, twenty-five or thirty feet high, and are hard, pearly, smooth, polished and papery, having sometimes a pur- Clam Harbor River. Search for gold.

plish or reddish mottled tinge, and containing whitish-grey chert in rusty, concretionary nodules. The slaty cleavage is easily detected when the rock is broken.

Below the Middletown road, Clam Harbor River cuts through greenish-grey and bluish quartzite and coherent shale or slate, with a tinge of purple. The rock called quartzite is here, as elsewhere, often a quartzose or quartzo-felspathic sandstone, with veins, sometimes eight inches thick, which appear to be always barren. Lower down, indian-red quartzite, passing into argillaceous sandstone, is associated with light-green and bluish shale These rocks extend in gorges and cliffs to the shore road, below which greenish slate and indian-red argillite are sometimes seen in a cultivated intervale.

On McPherson, Carey, Round and Welsh Lakes, and the brooks and roads of their neighborhood, similar shales, quartzites and conglomerates, stained with hematite, are abundant.

Iron ore of Ragged Head.

Ragged Head exhibits a salmon-colored jointed conglomerate, not unlike that of Arichat, associated with grey grit and conglomerate in variable bedding, and underlaid by fine, hard, indian-red sandstone and argillaceous shale. The paste is of quartz-felsite, and the pebbles—which range in size from cocoanuts to peas—of greenish and salmon-colored felsite and quartz-felsite. Hematite occurs in these rocks.

The banks of reddish boulder clay, between Ragged Head and Oyster Pond, show only blocks of fine quartzite, indian-red argillaceous sandstone, and hard, greenish-grey conglomerate, with pebbles of red syenite, quartz and quartzite.

Goose Harbor River.

Goose Harbor River displays, below the Welsh Lake road, the following strata:—

1. Greenish, felspathic, shaly sandstone.
2. Greenish and reddish, shaly, micaceous argillite, grit and fine conglomerate The foregoing rocks were seen in a small branch, quarter of a mile below the road.

Plants.

3. Quartzo-felspathic, compact sandstone, coarse grit and conglomerate, with shaly and thick-bedded rocks, like those of Rocky Bay. Many finely comminuted plants. The surface is often covered with knotty, calcareous concretions, and the sandy shales are rippled.
4. Argillaceous shale, with an approach to slaty cleavage.
5. White quartzite and fine grit, with purplish streaks; full of small quartz veins, in which are chlorite and calcite; interstratified with beds of soft, contorted argillaceous shale.

Probable boss of syenite.

6. Grey grit, resting upon what appears to be red, coarse syenite, but may be only a syenitic grit. The conglomerates previously seen contain pebbles chiefly of quartzite, and the felsite pebbles in them are not of this bright red variety. On the right bank of the river, ordinary bluish, greenish-grey and reddish quartzo-felspathic grit and sandstone are in place. Other grits and

conglomerates succeed lower down, formed chiefly of red syenite, a boss of which probably comes to the surface here.

7. Quartzite, arenaceous and argillaceous shale and coherent grit, full of quartz and calcspar veins. Reddish and purplish, greenish and grey shales, often mottled, extend a considerable distance, forming a beautiful valley, surrounded by rocky cliffs. The river widens into a small pond, about three quarters of a mile above the bridge on the shore road.

Above the Welsh Lake road, Goose Harbor River exposes fine felspathic sandstone, grit, conglomerate and allied rocks; and just below the Middletown road, cliffs of nearly compact quartzite, like that of Grand River barrens, is interstratified in massive beds, with bluish-grey, coherent argillaceous shale, and somewhat soft, quartz-veined, coherent sandstone. Above the bridge the river is very rapid and rough, or lies in long stretches of creek, the country being rocky as at the head of McNab Brook. Higher up, grey conglomerate also occurs. Cascades and gorges often exist where the brook runs along the strike of these rocks.

In the Meadows Brook, a short distance below Dorsay's, outcrops of these strata are found, as follows:— Meadows Brook.

1. Fine quartzo-felspathic, quartz-veined sandstone and greyish argillite.
2. Light green and purplish, often mottled, somewhat soft, though coherent, splintery, slaty argillite, dipping N. 50° E. $<$ 45°.
3. Bluish and reddish argillite, in thick beds, with quartz-veined sandstone. Very like the rocks of Lynch Creek.
4. Bluish-grey, micaceous argillite, about eighteen feet thick, in flaggy bands, easily separable into shales. Sometimes the layers are sandy rather than argillaceous, but very fine. There is no slaty cleavage, but the rocks are greatly jointed and traversed by small veins of calcspar and pyrite. Diligent search detected a few small pyritised markings of plants, the broadest of which measure only one-twentieth of an inch, and are longitudinally striated. Others are much finer, branching at an acute or right angle from a central stem. They bear a strong resemblance to certain parts of *Psilophyton*. Rusty-weathering calcspar veins abound, small and irregular, white and broadly crystalline, holding traces of iron and copper pyrites, as well as chlorite and minute grains, perhaps of talc. The shales break with a conchoidal fracture. The lowest are light green, soft, rough on the surface, passing into sandy rock, with quartzose masses and veins. Plants. *Psilophyton?*
5. Greenish and grey contorted shales and soft sandstones extend to the shore road, with red, thick-bedded sandstone and argillite, and purplish and greenish, mottled, coherent argillite. In the joints are sparkling, drusy crystals of quartz. Sometimes imbedded masses and lenticular layers of brown-weathering, compact, bluish-grey, pyritous ironstone appear; also doubtful organic forms, one of which resembles a broad *Cythere*, and a few obscure fucoids. Some of the rocks are brecciated.

On the shore road, near the Oyster Ponds, are ridges of greenish Oyster Ponds.

areno-argillaceous shale, with blotches of quartz, and occasional outcrops of light reddish-grey quartzo-felspathic grit, or very compact quartzite. Above the road, in the Oyster Pond Brook, is a dark-grey, micaceous, argillo-arenaceous shale, seamed with calcspar and with a soft, serpentinous substance between the layers. This contains *Naiadites* (?) and probably fish-spines.

Fossils.

Devonian Rocks of Inverness County.—Returning to the east side of the Strait of Canso, we find rocks very like those of Guysborough, underlying the limestone of Plaster Cove.* They consist of greenish, fine, spotted quartzo-felspathic sandstones, wholly different from those seen between Hastings and Hawkesbury; associated with dark-greenish, veined, very coherent shale and sandstone, Arichat conglomerate and black shales, containing markings of narrow stems of plants. A little further north, grey, very micaceous, somewhat coherent sandstone and coarse grit are underlaid by crumbling, grey, slaty, argillaceous shale, jointed and broken, very much altered; underlaid in turn by grey sandstone. The dip is variable, easterly and south-easterly. Grey and bluish-grey slates succeed, followed by a concealed interval, after which felsitic and syenitic rock is on the beach. Beyond the felsite, dark-purple, coherent, slaty argillite, like that of Rocky Bay, occurs. The actual contact is concealed, so that it is uncertain whether the felsite is intrusive or precambrian. Conglomerate, like that of Madame Island and Cape Porcupine, now forms a rocky point, with sheer cliffs. It is associated with veined, nearly compact, grey sandstone and grit, and extends to Long Pond. In the fields, behind this pond, these rocks, with reddish-grey, fine, coherent sandstone, overlie felsite and diorite..

Felsite.

McMillan Point.

Heffernan Brook again displays the contact of the felsite and conglomerate. The latter is grey, with a tinge of red, very compact; the pebbles nearly all consisting of felsite and quartz-felsite. There is also a very coherent, grey and greenish-grey, jointed grit a compact, hard, slaty rock, stained with hematite, and a quartzite, with veins of quartz and bright-green streaks. Associated with these, in intervals between the older rocks, is a dark-grey, soft argillite, with hematite in the joints. The dip varies, as will be seen from the map. The alternation of altered and less altered beds is noticeable.

Limestone quarry.

Beneath the limestone at the quarry, a mile and a half from Hastings, on the Victoria road, are outcrops of whitish, coherent grit and conglomerate, with many veins of quartz, apparently overlying the felsite of the hills. On the same road, near Brown's mill, and on Lake Horton road, quartz-veined, compact, coherent, splintery grit and sandstone

* Dawson's Acadian Geology, p. 390.

occur. North of the mill, the rocks more closely resemble those of Salmon Creek, being purple and grey quartz-veined grit, conglomerate and sandstone, often very rough, forming barrens. Rusty-weathering, friable, micaceous rocks, full of broken, carbonized plants, in one place dip steeply S. E. $<$ 45°.

On the General Line road, near Queensville Brook, are rocks probably also of this age—light-purplish, quartz-veined, compact, fine grit and conglomerate, the pebbles consisting largely of quartz. Bluish-grey, fine, friable, shaly sandstone occurs in one of the brooks, not far above the road, and blocks are found in the country adjoining. **Queensville Brook.**

Near the shore, at Horton Brook, coarse, coherent, grey quartzose sandstone, conglomerate and fine grit, jointed so as to obscure the dip, form a rugged country. Higher up, massive outcrops overlie hills or knolls of felsite in the fields. The distribution of the felsite is very irregular. Near a tributary from the Victoria road, an amygdaloidal variety occurs near greenish and grey, fine, micaceous, felspathic sandstone and quartzose grit; but its relation to them was not clearly made out. Another equally indefinite outcrop of fine diorite occurs above the tributary. In a brook flowing into Lake Horton, one quarter of a mile north of the outlet, is an outcrop of grey, fine quartzite, with perhaps a westerly dip, associated with ledges of grey grit. Around the lake, coherent, coarse grey conglomerate and quartzose grit form a rocky shore. In the large brook flowing into the west end of the lake grey fine grit, with a westerly dip, and greenish-grey, coherent, micaceous sandstone are followed by grey amygdaloid. It is possible that the latter may be part of the series, but it does not appear to have metamorphosed the surrounding rocks, and is probably older. Massive, fine, micaceous, grey and reddish, friable or coherent sandstone, grit and conglomerate rest upon coarse syenite on the path from the head waters of this brook to the General Line road. **Horton Brook.** **Contact of devonian and precambrian rocks.**

Below Brown's mill, on the north-west arm of River Inhabitants, there is a transition from the shales which prevail at Dorton's bridge to the following strata:— **Brown's mill.**

1. Reddish-grey, rusty-weathering, fine quartzose sandstone, in layers three to nine inches thick, broken into blocks by joints. The dip is S. 42° E. $<$ 43°.
2. Coarse, greenish-grey, conglomeritic grit, with specks of bright, silvery mica and veins of quartz and calcspar, so crumbly that it can be reduced to sand by gentle blows of the hammer. It dips apparently N. 65° E. $<$ 35°, but is very massive.
3. Still ascending the brook, we next find grey flinty quartzite, dipping N. 65° E. $<$ 56°, and passing into reddish quartzite, as much veined as any of the Guysborough rocks.
4. Dirty, greenish-grey, rusty, slaty argillite.

5. Quartz-veined quartzites occur at the mill, somewhat contorted, the country being very rocky.

6. Above the mill-pond are greenish-grey, fine conglomerate and grit, with argillaceous rocks of considerable variety, generally grey, greenish or bluish. Occasionally the grit is so compact that the grains are hardly distinguishable, and some of the finer varieties form a compact quartzo-felspathic rock that might belong to the Louisburg series.

7. Somewhat soft, though coherent sandstone, with Arichat conglomerate, grey, argillaceous shale and quartzo-felspathic grit. A few pieces of ordinary carboniferous sandstone are found in the boulder-clay.

8. Greenish-grey, friable, silvery, micaceous grit, like 2. These rocks continue to the first bridge on the General Line road.

9. Greenish-grey grit, with specks of silvery mica; compact quartzo-felspathic grit: greenish, grey and reddish, fine, micaceous sandstone and grit.

Doubtful intrusive rocks.

10. Just above the Louisburg felsites of the brook is a bluish-green, flinty, compact rock, perhaps an altered argillite, with very compact quartz-veined quartzite, grey coherent grit and splintery argillaceous rock.

11. Above the old road, from the Victoria to the General Line road, is a bright-red, slaty, coherent argillite, followed by fine grey diorite.

Beds resembling carboniferous.

Brown Brook, not far from the fork, cuts through a grey, fine, friable grit; and higher up, an indian-red argillaceous shale, not very coherent, with friable, fine conglomeritic grit, more nearly resembling a carboniferous rock of other districts than that usually seen. Above a path to the school, fine, reddish conglomerate is associated with a coarse syenitic variety. The comparatively small degree of alteration is remarkable, but not more so than that of certain little-altered portions of the primordial strata of the Bras d'Or Lake. Bright-red, slates of the Louisburg series succeed the rocks just described, and are sometimes with difficulty distinguished from them. Perhaps the conglomerates and other red rocks of this vicinity owe their color and softness to having been formed out of their ruins, although the grains and pebbles distinct enough to be identified consist of syenite and felsite, which have resisted abrasion better. Fragments of the soft clay-rock mentioned in the description of the felsite series (p. 12 F) appear, however, in the red grit and conglomerate.

Contact with felsite.

Sugar Camp Brook.

Sugar Camp Brook displays, above the Sugar Camp road, a greenish and reddish-grey quartzose sandstone, somewhat like that near Hartley's waterfall, Pirate Harbor. With this are associated fine reddish sandstone and micaceous, argillaceous shale. Similar rocks extend to the Victoria road, in the brook and fields. Descending Lamey Brook from this road, the first rock met with is a greenish-

Lamey Brook.

grey, coherent, fine, micaceous, white-weathering sandstone, with veins of milky quartz, interbedded with greenish-grey argillaceous shale, containing fragments of plants. The rocks are much jointed. Lower down is a fall over fine quartzose grit and sandstone. The latter is very variable, being sometimes very compact, at other times quite soft, and in color changing from greenish-grey to almost white. Just above a bridge, on the road below, are indian-red argillaceous sandstone and grit, composed almost wholly of quartz; and associated below the bridge with greenish-grey quartzose sandstone and conglomerate, containing pebbles of light colored marble. Grey shale is interbedded with the sandstone, which passes into quartzite, and is succeeded by purple and green mottled calcareous argillite, veined with calcspar, and containing a few geodes with crystals of calcspar. This is succeeded by the Plaster Cove limestone. Geodes.

In Lamey Brook, above the Victoria road, near the little lake, bluish-grey and brownish, grey-weathering, micaceous, thick-bedded sandstone dips S. 44° E. $<$ 57°. Outcrops of greenish-grey, micaceous, argillaceous sandstone are seen as far as the old road.

A good many exposures occur in the neighborhood of the Sugar Camp road, of grey, laminated, micaceous, argillaceous shale, with calcspar in the joints; fine purplish argillaceous sandstone; greenish-grey quartzose sandstone; mottled micaceous, argillaceous sandstone, which are often veined with quartz and highly altered. The dip varies as shown on the map. Sugar Camp road.

At Donald McQuarrie's, near Dorton's bridge, hard, grey conglomerate is overlaid by shaly limestone. Blocks of purplish, softer grit and sandstone, and of grey argillaceous shale, also appear near Donald McKinnon's. Dorton's bridge

Overlying the crystalline limestone, in Queensville Brook, above McInnes' mill-pond, are beds of coarse and fine, coherent, light-reddish-grey, slightly micaceous, felspathic grit, containing seams and blotches of pure, white quartz, and pebbles of reddish felspar and quartz. This alternates with indian-red, fine, argillaceous, micaceous sandstone, and light-red, compact, jointed quartzite, grit and argillite, calcareous, and seamed with calcite. With these is found reddish, very coherent conglomerate, with pebbles chiefly of quartz. The lowest bed of this series is a grey and greenish quartzite, without evident bedding. Below the Victoria road these rocks present the following varieties in descending order:— Queensville Brook.

1. Grey and purple conglomerate and grit.
2. Coherent, purplish and greenish argillite.
3. Red-purple marl, with greenish and grey spots of lenticular, concretionary limestone.

4. Reddish coherent grit.
5. Bright indian-red, fine, crumbling sandstone and grit of ordinary carboniferous aspect, dipping S. 53° E. < 42°.
6. Grey, coherent, coarse grit, and reddish, rather friable conglomerate, like that seen in the north-west arm of River Inhabitants, near the contact with the red slaty felsite.
7. Grey, coherent, quartzose sandstone.
8. Whitish, fine, jointed, quartzo-felspathic grit, with specks of silvery mica.
9. Slaty, greenish shale, like that seen near Dorton's bridge.
10. Whitish conglomerate, sparkling as if wholly composed of quartz; veined, slaty, micaceous, coherent argillite, grit and conglomerate.
11. Greenish-grey, fine, micaceous, coherent sandstone and slate, with a tendency to break into regular pieces. Dip S. 64° E. < 45°.
12. Light-grey and bluish limestone, compact, and more or less impure, 2 feet 6 inches.
13. Greenish, slaty argillite, crumbling into knife and needle-shaped pieces, 4 feet.
14. Red coherent grit, 3 feet.
15. Quartz-veined, quartzose conglomerate, forming the north wall of a cliffy gorge.
16. Very coherent conglomerate and grit, quartz-veined and jointed, extend to the Victoria road.

Some of the rocks north of Craignish may also be devonian, but as they appear rather to be carboniferous, they will not be referred to here.

CARBONIFEROUS FORMATION.

Character. The rocks of this formation are generally much less altered than those just described, although in this respect there is great variety. For while the sandstones and shales overlying the limestone at Plaster Cove are nearly as much altered as those beneath it, some of those of River Inhabitants are little more than hardened sand and mud. The

Subdivision. separation into groups of the great mass of sediments comprised in this formation, within the region to which this report refers, is extremely difficult. It is probable that there are at least two unconformable series as suggested by Mr. E. Gilpin, Inspector of Mines for Nova Scotia; but the unconformity is not so pronounced, and even more difficult to trace, than that between the devonian and lower carboniferous rocks. To the lower of these groups, may belong both the coal seams which have been wrought in the Richmond coalfield and those of Upper River Inhabitants, in which case the limestone of Glendale is that of Plaster Cove; the coal seams are identical, and the shale in River Inhabitants containing *Leaia leydii* is on the same horizon as that on the Strait of Canso holding the same fossil. Moreover, if the assumption that the St. Peters limestone is also that of Lennox Ferry be correct, a similar *Leaia* shale should occur at River Bourgeois and Seal Cove, unless uncomformably overlapped. Then the "coal measures" of

Scott Brook would represent those of the Richmond coalfield; and the highest rocks in the field occur in the syncline between Inhabitants Basin and West Bay. There are difficulties involved in this hypothesis, however, connected with the apparently merely local development of the plaster, limestone and coal of Little River, which must be explained before it can be accepted.

Several faults traverse the region, but their position and amount cannot yet be accurately stated. One of these throws down the Janvrin Island strata, and is perhaps continuous with that indicated by the steep dip along the Strait of Canso, about Bear Island. Another runs from the south-western extremity of the North Mountain felsites to the westward of McIntyre Lake, thence down Little River south of the mine, passing to the shore either in the low land at the mouth of the river or on Carleton Head. The Carleton Head fault is probably also a continuation of that which strikes the Strait of Canso north of Ship Point. These are all downthrows on the west side. Minor faults are indicated at other localities as in White Brook; and in tracing the coal seams, several are stated to have been met with. **Faults.**

The thickness of the strata is about 22,000 feet; and this, perhaps, represents the entire section of the several groups into which the carboniferous formation is divisible in other districts, although the strata are somewhat different and the coal seams of less persistence than those of Sydney, Port Hood and Pictou coalfields. **Enormous thickness.**

On Madame Island few rocks of this formation appear. On the shore of Rocky Bay, south of the outlet of Shaw Lake and on Fourgier Point, blocks of gypsum are met with. Near the head of Arichat Harbor is an outcrop of light-grey, thick-bedded, dirty, pebbly limestone, drused and veined with calcspar, dipping N. 16° W. $<$ 30°. No fossils were detected. A deposit of gypsum, which has been quarried to some extent, shows about ten feet high in the bank, and dips every way from the centre of the quarry outward. It is of white, bluish, mottled-white and grey, red and other colors, selenitic and finely crystalline. The deposit seems to be surrounded on all sides by conglomerate belonging to the older series. The soil in the back streets of Arichat, here about, is carboniferous, although no rocks are met with. Further west the gypsum forms mounds and behind the chapel an exposure of dark-grey, pure or sandy, compact limestone, sometimes nodular, seamed with calcspar, containing encrinite stems, but apparently no other fossils, lies between dark, bluish-grey felsite on the north, and conglomerate on the south. It is seen for about sixty yards striking indistinctly S. 75° E. That this does not form a part of the conglomerate series, cannot be confidently asserted. Too little of these exposures was seen to determine their relations, but probably the limestone and plaster of **Madame Island** **Limestone and gypsum of Arichat.**

Age of the limestone.

Arichat are of the same age as those of Lennox ferry; on the other hand, the limestone north of the Crid Islands, may be newer than devonian. The two are different, however, the latter being reddish and lenticular, that of Arichat bluish, highly crystalline, and very like that of St. Peters.

Limestone and gypsum of Lennox ferry.

Near Lennox ferry is another important outcrop of plaster and limestone, associated with reddish conglomerate and light indian-red, soft, argillaceous sandstone. The plaster forms mounds and pits, breaking the ground up in a remarkable manner. It is generally white, bluish and pink, good, often selenitic, and associated with greenish and reddish marl. The dip at the quarries seems to be N. 5° E. < 25°. Barrens surround the pits, on which no rocks are seen. Limestone is also largely quarried in the neighborhood. It is a bluish-grey and grey, dark, bituminous rock, full of whitish calcspar in veins and crystals, and containing innumerable fossils, chiefly encrinites and brachiopods, but also polyzoa and *Conularia*. Crystals of iron pyrites and dog-toothspar also abound. The conglomerate contains a great number of pebbles of the Arichat devonian series—coherent sandstone, quartzite and softer shales, not so compact as the quartzite pebbles of the devonian conglomerate, but evidently derived from rocks like those of Descousse and Grand Lake. It is also of the usual carboniferous aspect, little altered, rather crumbly, and very calcareous. One remarkable circumstance may be mentioned: it appears to contain pebbles of the limestone worked in the adjacent quarry, which would make this also of devonian age. Perhaps, however, these are concretionary, and were formed in the rock during or subsequent to its deposition. The concretions are compact and splintery, like the limestone of Robinson Cove and St. Peters.

Fossils.

Limestone conglomerate or concretions.

Martinique.

Between Lennox ferry and Martinique, only pink soil is displayed, with blocks of grey sandstone, containing plants sometimes of large size, and purplish and indian-red grit passing into conglomerate. The character of the country is the same all around Glasgow Point. For a short distance along the Martinique roads towards West Arichat, rocks similar to those between Scott Brook and St. Peters are present, succeeded by the underlying slates and quartzites. Limestone and gypsum are reported to occur on Glasgow and Thorn Points, but their being in place is doubtful.

Janvrin Island.

The rocks of Janvrin Island are interesting, because of their resemblance to those of the north side of Lennox Passage, although they are on the strike of the devonian rocks, a position they appear to occupy from the interposition of a fault. Near Dory Point huge blocks of shaly limestone and gypsum lie on the reefs and in the banks of the outer shore of Le Blanc Harbor. The reefs of Peninsula Point consist

of grey, shaly sandstone, apparently carboniferous. On the south side of Janvrin Point red and green, crumbling, sandy shales, with flaggy more coherent layers, dip about N. 13° W. < 50°, and extend in fine cliffs to the beginning of the beach at the head of Janvrin Bay. Just beyond the beach, and at Thomas Head, similar rocks again occur.

The highest rocks appear on the north shore, about two-thirds of a mile east of Thomas Head. From this point they strike both ways for some distance along the shore, the section to the westward being as follows in descending order: Section on the north side of Janvrin Island.

	FEET.	INCHES.	
1. Reddish and greenish, waving, rippled, calcareous, concretionary, fine sandstone and argillaceous shale. In cliffs for about a quarter of a mile on the most northerly point. Dip N. 21° W. < 77°	107	0	
2. Grey and bluish-grey, shaly and thick-bedded sandstone, marked with glacial striæ. Comminuted carbonized plants	30	0	Plants.
3. Reddish, greenish and grey argillaceous shale and sandstone.	56	0	
4. Grey and greenish-grey sandstone with broken plants	18	0	
5. Grey, greenish and reddish argillaceous shale	12	0	
6. Grey sandstone	122	0	
7. Reddish, soft, argillaceous shale, with hard red and grey bands	94	0	
8. Greenish-grey and reddish waving sandstone	18	0	
9. Reddish sandstone and argillaceous shale. Dip S. 57° W < 67°	281	0	
10. Grey, greenish and bluish-grey sandstone, sometimes shaly and waving, with concretionary, calcareous patches. Often rusty, crumbling and broken. Irregular layers of greenish argillaceous shale. Remains of plants	69	0	
11. Red argillaceous shale, with hard calcareous sandstone bands	55	0	
12. Measures concealed by a marsh and beach. Dip N. 20° W. < 67°	552	0	
13. Measures concealed. Occasional reefs of red sandstone and argillaceous shale	147	0	
14 Reddish sandstone and argillaceous shale, with greenish bands. Ripple marks. Dip N. 20 W. < 70°	103	0	
15. Measures concealed by a large pond	650	0	
16. Occasional exposures of reddish and greenish argillaceous shale on the reefs	140	0	
17. Measures concealed	188	0	
18. Greenish-grey and reddish, waving, shaly sandstone	15	0	
19. Measures concealed	50	0	
20. Red, greenish and grey, finely laminated, argillaceous shale, like that of the brook near the chapel at Inhabitants Basin	56	0	
21. Reddish and greenish, dirty, argillaceous shale and sandstone	52	0	

22. Reddish, greenish and purplish argillaceous and arenaceous shale, with harder sandstone bands	174	0
23. Measures for the most part concealed. Reddish and purplish argillaceous shale and sandstone occasionally seen. Dip N. 13° W. < 65°	435	0
24. Measures concealed by Janvrin Harbor. Dip N. 17° W. < 60°	1316	0
25. Reddish and greenish mottled, friable, micaceous, argillaceous and arenaceous shales or flags, jointed and cleft; seamed with calcspar, with bands of coherent flaggy sandstone. Seen on Janvrin Head	147	0
Total thickness	4887	0

The upper part of this section at Thomas Head differs somewhat from the above.

4. Grey sandstone seen for a considerable distance on the rocky coast	52	0
5. Greenish, crumbling, argillaceous shale	19	0
6. Grey, greenish and bluish-grey fine sandstone full of broken plants, large calamites, etc	103	0
7. Reddish and greenish fine argillaceous shale (No. 7 above)	94	0
Total thickness	268	0

To the eastward of the reddish sandstone (No. 1) of the first section, the measures are repeated in descending order, as follows:

	FEET.	INCHES.
1. Reddish shale and sandstone (No. 1)	107	0
2. Grey, waving sandstone. Plants. Rain prints?	57	0
3. Grey shaly sandstone with large concretions and broken plants. A fern ten inches long	12	0
4. Greenish, bluish and grey argillaceous shale, full of seaweeds and ripple-marked	8	0
5. More arenaceous rock, holding rootlets, and passing into a grey rusty sandstone with roots of trees often converted, two inches through, into coal and pyrite. Grey, conglomeritic, calcareous patches. The lowest beds have an overturned dip	12	0
6. Reddish and greenish argillaceous shale	45	0
7. Grey sandstone	15	0
8. Reddish and greenish argillaceous shale and sandstone	97	0
9. Measures concealed	..	..
Total thickness	353	0

The dip turns more to the south-eastward and gives a great thickness of red rocks the order of which is ascending, unless the dip is overturned. The first exposure is about 328 feet from No. 9.

		FEET.	INCHES.
1.	Reddish-grey sandstone	48	0
2.	Measures concealed by a small pond	290	0
3.	Red rocks; not well seen	183	0
4.	Alternations of red, greenish and purple argillaceous shale with bands of sandstone. Dip S. 60° E. < 70°	870	0
5.	Grey sandstone	12	0
6.	Alternations as in No. 4	505	0
7.	Greenish, reddish and grey sandstone. Dip S. 62° E. < 61°.	70	0
8.	Reddish rocks, not well seen	52	0
9.	Measures concealed. Dip S. 53° E. < 61°	670	0
10.	Reddish and greenish argillaceous shale and sandstone, obscurely seen	383	0
11.	Grey sandstone	30	0
12.	Reddish and greenish argillaceous shale	52	0
13.	Measures concealed. Dip S. 55° E. < 56°	1285	0
14.	Red rocks obscurely seen to the southward of Strawberry Point, dipping S. 55°E. < 52° at the beginning, and S. 60° E. < 70° at the end of the exposure	1014	0
	Total thickness	5464	0

There is nothing distinctive about the strata of Janvrin Island but an indefinite mass of variable sediments, probably at the horizon of those between Port Hastings and Hawkesbury, but deposited for the most part in a deeper sea, the dark shales of the Strait of Canso being absent or concealed.

Campbell Island shows only gravel banks with large blocks of carboniferous sandstone. Campbell Island.

Guysborough Carboniferous Rocks.—At Star Point, on Guysborough Harbor, is a reddish and whitish conglomerate, which if found on the Bras d'Or Lake would at once be pronounced carboniferous. Of this it may unhesitatingly be said that it is newer than the quartzites and slates of the vicinity, seeing that it contains many pebbles and blocks of these latter, with their characteristic quartz-veins and aggregations of specular iron ore. The pebbles vary in size from peas to blocks nine inches in diameter, and comprise chiefly greenish, soft, argillaceous shale, green and red mottled rocks, like those examined on the coast at Stewart Pond, and grey, greenish and bluish quarzites, often quartz-veined and ferruginous. But the greater part of the rock consists of a limestone of various colors, banded and waved, which looks as if derived from a pre-existing limestone, but is more probably another example of the concretion-forming agency so often alluded to in connection with calcareous strata as producing masses of limestone breccia. Some portions consist altogether of this breccia, and in one of the

Guysborough Harbor.

Limestone.

pebbles was found a beautiful little crystal of quartz. The binding agent of the whole mass is limestone, limestone-grit and very calcareous sandstone, sometimes fine and crystalline, but often coarse and mixed with pebbles of older rock. Dipping steeply northward, further down the harbor is a bluish limestone-breccia, enclosing a few large quartzite blocks, overlaid by shaly, jointed, light-colored limestone. It has been burnt for lime, and is like that of St. Peters. Close behind these rocks come the quartzites. In a brook between Star and Katon Points the limestone forms a high cliff, dipping nearly vertically about N. 18° E. At Katon Point, similar rocks occur, and at Marshall Point a light-colored, reddish or bluish-grey hematitic, shaly limestone, veined with calcspar, sometimes brecciated and contorted, bears a strong resemblance to the cambrian limestone about Boisdale. In the cliffs it is often highly crystalline, but somewhat impure, and traversed by a network of calcspar veins. It comes boldly to the water, where it is hollowed into small caves. Being so much veined, broken and twisted, the chance of finding fossils in it is small. North of the ferry at McCaul Island are red, coherent, calcareous rocks, with contorted limestone breccia or conglomerate. The soil is bright indian-red.

Martin Pond. Immediately west of Martin Pond, on the shore, is a nut and egg-conglomerate, to all appearance carboniferous, containing pebbles of quartzites in a calcspar paste. Then follows a concealed interval, after which are occasional outcrops of red, crumbling conglomerate, associated with an indian-red and grey sandstone, easily reducible to sand under the hammer, but containing small, hard pebbles. Bright-red and grey colors appear in irregular bands, and certain grey or whitish-green spots are hard and coherent. The dip is about N. 50° E. $<$ 25°. Where washed by the waves, these red and green rocks are finely carved, owing to the unequal hardness of different parts, and where calcareous matter abounds in nodular patches, rough knobs cover the weathered surface. Further south the dip is S. 50° E. $<$ 15°. The sandstone is everywhere pebbly, but the pebbles are small. Just before the section is interrupted by Hadley Beach, grey and red friable sandstone dips S. E. $<$ 20°.

Ragged Pond. A short distance below the shore road, at the head of Ragged Pond, a small watering brook cuts through another outlier of carboniferous rock, consisting of bright, crumbling marl, fine shaly sandstone, coarse grit and fine conglomerate with green blotches, precisely like strata of this formation on the Bras d'Or Lake and other parts of eastern Cape Breton, but unlike those seen about the Strait of Canso or Chedabucto Bay. The dip is south-easterly, at an angle varying from

5° to 20°. Some of these rocks can be easily crushed between the fingers.

Above the road, at Steep Creek, on the Strait of Canso, is another small indefinite outlier of soft limestone and shale, probably carboniferous. Steep Creek.

Behind the post-office at Pirate Harbor, and just west of the road, is a long line of pits, some of which are full of water. The country is also greatly broken. This is almost certainly due to the presence of gypsum, which has also been found in small pieces further north, near the limestone quarry. Greenish and bright-red soft marl, with traces of gypsum, appear in the valley leading to McNeil's quarry. The question of the age of the quarry limestone has already been discussed; it seems, where it comes in contact with the underlying conglomerate, to rest conformably upon it, nearly vertically, but in its general mode of occurrence appears to strike in a somewhat different direction. Gypsum and limestone of Pirate Harbor.

At the south end of Cape Porcupine, on the shore, is a piece of lowland exhibiting traces of reddish soil, pits full of water, and probably plaster pits, and an outcrop of limestone. Cape Porcupine.

On the shore, west of Havre-au-Bouche, the detritus is bluish and reddish shale and sandstone. On the western point, a few pieces of gypsum and grey fossiliferous limestone occur, showing plants. A quarter of a mile from the harbor, greenish-grey fine sandstone, with impressions of plants, thick-bedded or shaly, and underlaid by reddish, jointed, calcareous, waving, ripple-marked shale, dips N. 7° E. $<$ 30°. At Cape Jack, reddish and purplish shales are overlaid by dark-red, finely laminated, soft, argillaceous shale, with bright-green spots, including harder layers of sandstone and arenaceous shale, often in lenticular masses. These are overlaid by limestone, apparently about ten feet thick, of various shades of bluish-grey, coherent but finely laminated and waving. These rocks have a decidedly carboniferous aspect, and are less altered than their probable equivalents on the north side of the strait, where they have been crumpled and compressed. It would be interesting to trace them past Tracadie to see how far they resemble the rocks of the strait, and to ascertain under what circumstances the "coal measures" occur here. Havre-au-Bouche. Cape Jack. Limestone.

At Blue Cape, bluish, layered, veined limestone, twisted, variable and sometimes in concentric circular masses three feet or more in diameter, is underlaid by purplish, fine, soft, micaceous sandstone and arenaceous shale containing fucoids, succeeded in turn by indian-red, soft, crumbling marl, with several beds of soft, red and green-mottled sandstone. The limestone contains *Conularia:* it is often oolitic, always much veined, and fifteen or twenty feet thick, resembling that seen on the Blue Cape. Oolitic, fossiliferous limestone.

shore east of Havre-au-Bouche. A little further up the bay, beyond Blue Cape, indian-red, soft, carboniferous shales, and fine flaggy sandstones dip N. 80° W $< 10°$, which is the attitude of the rocks as far as the salt pond at the beginning of Little Tracadie inlet.

Carboniferous Rocks of Richmond and Inverness.—Returning again to Richmond and Inverness counties, we may remark that mention was omitted in last report of an outcrop of limestone, probably carboniferous, that occurs in the quartzite region, on the shore at the south-eastern end of Loch Cailean. It is a bluish or grey, rusty-weathering, white-spotted, vesicular variety. Below Smith's mill, too, near the Black Brook, a tributary of Grand River, blocks are found of a red calcareous conglomerate, strikingly unlike that of L'Ardoise, blocks of which are also near; and on the Soldier Cove road north of this brook, reddish, crumbling detritus, seemingly indicating a small outlying patch of this formation, appears for a few yards. The limestone of River Tom is so folded among the underlying quartzites, that it seems impossible to completely separate the two series on a map. This folding is perhaps accompanied by a fault extending along the anticline of the East Bay Hills, and perhaps passing into it. The attitude of the strata to the eastward along this ridge, and the steep dip of the millstone grit away from the hills, no lower rocks being present, seems to confirm this supposition.

Limestone at Loch Cailean.

River Tom.

Peter's Mountain.

The limestone at Peter's Mountain, Loch Lomond, described as carboniferous in a previous report, is the same as that of River Tom, and would appear here also unconformably to overlie the quartzite series, unless the blocks found about the lake are boulders.

The mineral character, geological position, and fossil remains of the lower rocks of this formation in the district of St. Peters, towards the Strait of Canso, and in the valley of River Inhabitants, resemble those of Horton Bluff, described by Dr. J. W. Dawson in Acadian Geology, p. 252. There is an alternation of marine, estuary and dry land conditions of deposition indicated by the beds which compose the series. At the base is the great marine deposit of limestone and plaster found at St. Peters, Lennox Ferry, Pirate Harbor and Plaster Cove, followed by a great thickness of coherent shales containing *Leaia leydii* and other fossils, and by reddish and grey sandstones containing plants. Then a series of "coal measures" exhibits black shales, full of *Naiadites, Cythere, Spirorbis*, fish remains and plants, including upright trees. Ironstone nodules abound, and in several places coal seams have been discovered and wrought.

Five basins.

These rocks lie in five synclines or basins. The first extends from the shore of the Bras d'Or Lake to Couteau Inlet; a second fringes West Bay; a third occupies the country between Couteau Inlet, Plaster

Cove and the Long Stretch bridge; another lies between North Mountain and Craignish Hills; whilst the fifth, to the westward of Craignish Hills, contains the Port Hood coalfield.

From St. Peters to Scott Brook there are few rocks, either on the road or on the shore, and wherever seen they consist of grey and reddish, fine, somewhat coherent sandstone. In Scott Brook, however, there are good exposures. At the shore road the brook flows among meadows and broken marshes, but higher up, in a wide valley with high, rocky banks, the country being for the most part, barren and the soil clayey. Pieces of rusty-weathering, rippled sandstone occur not far above the road, and immediately beyond this rock is in place, dipping S. 60° E. $<$ 13°, in an exposure which possesses the highest interest. The sandstone is fine, bluish and grey, friable, shaly and flaggy, containing carbonized plants, leaves and obscure *Stigmaria*. Its surface is covered with impressions of *Naiadites elongata*, *Cythere*, *Spirorbis carbonarius* and *S. arietinus*.* It passes into and is interstratified with highly bituminous, bluish or light-grey, green-spotted, crystalline, concretionary or sandy limestone; this, too, contains the same fossils, being in places wholly made up of entomostracans. Beautiful palatal teeth of a new species of *Psammodus** spot the surface in great numbers. They are a quarter of an inch in length, rhomboidal or broad leaf-shaped, brown and polished. Higher up the brook are cliffs of grey, black-streaked, argillaceous shale and flaggy, fine sandstone, dipping almost horizontally to the northward, finely ripple-marked, micaceous and covered with minute carbonized plants, fucoids and fish scales. Small patches of fine conglomerate also occur. The sandstone is overlaid by grey marl and limestone in thin beds, the latter predominating and being sometimes made up of shells, fish spines and *Naiadites*. The dip is variable and the thickness uncertain. Similar rocks higher in the brook accompany a bluish or black soft shale, often a mass of *Naiadites*, as closely packed together as in the bituminous shales of the Sydney coalfield, and abounding in *Cythere* and coprolites. The limestone is sometimes in lenticular layers in the marls. As in the Sydney coalfield, the shales contain the fossils in varying numbers, being sometimes a mass of them, at other times showing every separate shell distinctly imprinted on the stone. Sandstone and arenaceous shale succeed, with bluish marl containing ironstone nodules in layers. The sandstone is indian-red and light sea-green, in distinct beds or mottled patches. Many impressions of calamites and other plants occur, covered with films of coal. Some of the beds are fine and beautifully waved, breaking out in large blocks varying from half an

Scott Brook.

Fossils.

New species of Psammodus.

Bituminous shales.

Fossils.

* Determined by Dr. J. W. Dawson.

Ironstone nodules.

inch to three inches in thickness. Below this lie bluish and black, argillaceous, *Naiadites* shale, holding a few scattered nodules of light-grey ironstone as large as cocoanuts, some of which are filled with beautiful crystals of various minerals, including a blackish radiating mineral. Alternations of reddish and greenish marl and sandstone follow, with a few coherent beds of impure limestone, a greenish, rusty, crumbling, argillo-arenaceous underclay, three feet thick, full of *Stigmaria* and rootlets, underlaid by three feet of rather coarse, coherent, rusty sandstone, containing few *Stigmaria*. Purplish and greenish rocks then alternate, but are only seen at intervals as far as Malcolm Ross'.

Underclay.

In a tributary flowing into Scott Brook in Malcolm Ross' clearing, the following descending section is presented:

	FEET.	INCHES.
1. Grey and bluish, brown-weathering, sandstone, with blotches of coaly matter Indefinite........................		
2. Grey, ripple-marked sandstone in layers....................	1	6
3. Reddish sandstone..	2	0
4. Bluish arenaceous shale with markings of carbonized plants.	1	0
5. Red arenaceous and argillaceous shale.....................	8	0
6. Bluish argillo-arenaceous shale..........................	1	0
7. Grey, nearly compact, calcareo-micaceous sandstone, dipping N. 25° W. $<$ 22°..................................	3	0
Total thickness..........................	16	6

Few outcrops are seen higher up, the brook flowing in low ground.

Rocks, probably the same as those just described, are again found in a tributary of Scott Brook above the shore road, as follows:

	FEET.	INCHES.
1. Bluish and greenish argillaceous underclay, with rootlets, impure ironstone nodules and bright rusty streaks. Sometimes this rock is so full of *Cordaites* as to assume the character of black shale.......................		
2. Limestone and fine, rippled, calcareous sandstone in thin beds more or less nodular. Perfect spheres of sandstone have been found in these beds..........................		
3. Argillaceous shale containing *Naiadites*, with layers of compact sandstone and nodules of limestone.............	6	0
4. Grey and bluish, flaggy, nearly compact sandstone, dipping N. W. $<$ 8°.......................................	6	0
5. Marl and limestone in thin and thick crumbling layers, containing *Spirorbis*, *Cythere* and *Naiadites*..............	12	0

Black shale.

Shells.

Junction of carboniferous and precambrian strata.

In another branch of Scott Brook grey, fine, flaggy sandstone in cliffs containing red and green spots, dips S. E. $<$ 60°, and is underlaid by greenish, crumbling, calcareous, soft, talco-felspathic, pearly, contorted Louisburg shales, dipping steeply about S. 80° E.

On the barrens of the Cranberry Lake road, greenish and grey fine sandstone, marked with plants and resembling that seen on the Grand River and Loch Lomond barrens, although less altered, is associated with reddish sandstone and purple grit, sometimes shaly, like the devonian rocks of Salmon Creek. Mossy barrens, marshes and spruce-land occur about Cranberry Lake. In a brook flowing into the lake, a grey fine sandstone dips doubtfully S. E. $< 60°$. Near the outlet, greenish and grey, fine, shaly sandstone full of minute fragments of carbonized plants, dips N. 25° W. $< 45°$. In the presence of grey sandstone full of carbonized plants, and in the small seams of coaly matter found among them, they are also very like the millstone grit in the Sydney coalfield, an analogy noticed by Mr. Brown. The only rocks of greater age which resemble them are the coal-bearing strata of McAdam Lake. (Report for 1876-7, p. 441.) Cranberry Lake. Carbonized plants. Likeness to millstone grit.

In a brook near George Creek, blocks of grey or greenish-grey, fine, shaly sandstone appear just above the road. The lakes from which it flows are sometimes marshy; the shore is, however, often stony, wooded chiefly with small spruce, Indian pear, *Amelanchier*, and hazel bushes, which in places overhang the water. The country is, like that described as millstone grit in other districts, covered with blocks of grey and reddish-grey fine sandstone. Blocks of conglomerate, limestone and gypsum occur on the shore of St. Peters Inlet, but as no rocks *in situ* indicate the dip, and the brooks being few, small and slow flowing, it is difficult to ascertain the structure in this piece of country. George Creek.

Carboniferous strata form a fringe around the precambrian rocks of West Bay, from Cape George to Ross Creek, being sometimes seen on the brooks and shore, but more frequently concealed by boulder detritus. On the shore of West Bay, near Morrison Harbor, white, grey and reddish plaster is associated with limestone composed of shells. Huge blocks of limestone occur to the westward, where several lime-kilns are in operation.

On the Morrison road, sandstones, interstratified with conglomerate, argillaceous shale and a small patch of plaster, rest upon the felsites. Morrison road.

In the main branch of River Tillard, flowing from Mountain Lake, reddish argillaceous sandstone and grey and red argillaceous shale passing into fine conglomerate and sandstone, holding pebbles of felsite and quartz, overlie the precambrian rocks, and are overlaid down stream by thick-bedded, micaceous, argillaceous sandstone, associated with bands of light-grey jointed argillite, containing a soft, soapy mineral in the joints and bedding planes. The dip is south-easterly. Below the bridge on the Morrison road, grey and greenish, fine, rough-weathering, flaggy, ripple-marked sandstone dips N. 21° W. $< 14°$. At the Contact of carboniferous and precambrian strata.

River Tillard falls.

falls, similar sandstone has joints running S. 14° E. and S. 33° W. Ill defined outcrops of greenish-grey sandstone extend to the head of tidewater, a short distance above the St. Peters road. The blocks of grey sandstone, covered with carbonized plants, which occur on the road from River Tillard bridge to the shore, there give place to others of grey and reddish fine sandstone and conglomerate. Only blocks and pebbles imbedded in clay are found as far as the entrance of River Bourgeois.

River Bourgeois.

Coherent purplish conglomerate, grit and argillite detritus abounds about River Bourgeois; and sandstone on the road from this village to River Tillard bridge, past Sutton's. Near the shore between River Tillard and St. Peters, no rocks are seen in place, although the land is covered with blocks of shaly and thick-bedded reddish and grey sandstone, very like the millstone grit strata of Mira Bay, which contain a larger proportion of red beds than those of Sydney Harbor.

The country between the St. Peters road and River Bourgeois shows no outcrops, yet there can be no doubt concerning the nature of the underlying strata, as the surface is rendered literally barren by the number of huge blocks of fine greenish-grey and reddish sandstone that encumber it. It is precisely like the millstone grit areas of the Sydney coalfield, but the soil is pink rather than rusty, owing to the greater number of red beds. The district has been devastated by forest fires, and wherever trees occur they are of second growth. The St. Peters road may be taken as a fair sample of the whole district. The brooks are small and flow in valleys of greater depth of soil than is to be seen on the neighboring hills. A strip of good cleared land runs along River Bourgeois.

River Tillard.

In the east branch of River Tillard, reddish-grey fine sandstone, with layers of fine, pebbly, calcareous grit or concretionary limestone and mottled-red and green, jointed and shaly or crumbling argillaceous rock dips N. 24° W. $<$ 45°, and lower. Above the footpath to John McNeil's, red and grey fine argillaceous sandstone somewhat coherent, dips N. 30° W. $<$ 30°, in flaggy beds, succeeded by cliffs of fine, micaceous, red and grey sandstone, shaly, jointed and crumbling, with nodular argillaceous rock, red or mottled-red and green, fine, concretionary, and passing into impure, brownish, compact limestone. Similar rocks, with irregular beds of calcareous conglomerate, continue nearly to the bridge at McNeil's. Above this bridge a few outcrops of reddish fine sandstone dip N. 25° W. $<$ 25°. Much of River Tillard consists of intervales and hay marshes full of broken ponds.

In a brook flowing into River Tillard from the Morrison road, jointed, reddish and grey sandstone, fine grit and concretionary limestone in

conglomeritic patches, with dark spots of argillaceous matter, contain much calcspar, often aggregated into veins with vugs lined with dog-tooth spar. These are interstratified with soft red and green rocks and with a calcareous grit, having a north-westerly, nearly vertical dip. Similar concretionary, calcareous rocks form occasional small exposures in the brooks of the neighborhood, with varying dip. In another branch below the Morrison road, cliffs of blackish-grey and red argillaceous flags dip S. 30° E. $< 45°$. Nearer the road these rocks are associated with red sandstone and friable calcareous conglomerate, containing large pebbles, and rest upon the felsites of the hill. In the first large brook north of William Urquhart's, grey, coherent, calcareous, rusty-weathering sand stone dips S. 68° W. $< 45°$.

It will be remarked that the limestone of St. Peters and Lennox ferry is absent on this side of the basin, only the higher rocks being present. Possibly this may be due to a fault, but this is unlikely, as a conglomerate or basal rock seems to pass into the argillaceous and arenaceous strata found further from the hills. It is more probable that this limestone was overlapped by the newer rocks, as the hills, existing then where they do now, were slowly sinking beneath the sea.

In Indian Creek, below Lauchlin McLean's carding mill, on False Bay Lake, and also in a brook flowing into it from Grand Anse post-office, grey and red sandstones are associated with grey nodular limestone, argillite and conglomerate. At tidewater, the low banks display grey sandstone resembling millstone grit. **Indian Creek.**

On the St. Peters road, near McPherson's, reddish-grey argillaceous sandstone, containing calamites, dips S. 43° W. $< 60°$.

On the road to Grandique ferry, pieces of broken sandstone occur, and east of the ferry road, reddish and grey, calcareous, false-bedded sandstone and argillaceous shale dip S. E. The dip is greatly contorted on a sharp anticlinal axis running south along the Grandique road. **Grandique ferry.**

2nd Syncline or Basin.—In the north branch of River Moulin, west of McPherson's, purplish, reddish and greenish, mottled, very micaceous, arenaceous shale and fine flaggy sandstone dip S. 45° W. $< 45°$, waving and covered with innumerable black fragments of plants and fucoidal markings. On the slope of McDonald Mountain, reddish calcareous conglomerate overlies the precambrian felsites, and in the brook flowing from Buchanan Lake, flaggy, apparently vertical, argillaceous rock strikes north. A fault is perhaps indicated by the high dip here, and also at McRae's mill and White Brook. On the wet barrens between McFarlane's, at the St. Peters road, and McRae's grist mill, on which sundew plants abound, sandstone and shale are indistinctly seen. Near the mill, grey nearly compact sandstones, full of streaks of coal **McDonald Mountain.** **Faults.**

derived from carbonized plants, and not unlike some of the strata of Salmon Creek, sometimes coarse, with specks of mica, dip S. 62° E, nearly vertically. Near the spring above McIntyre Lake, fine, reddish and grey, shaly and flaggy, micaceous, arenaceous and argillaceous rocks dip N. 85° W. < 18°, forming cliffs.

McIntyre Lake

Just below the bridge, near the settlement at River Moulin, is a ridge of flaggy, smooth-bedded, grey sandstone, dipping S. 70° W. < 52°; and on the shore, reefs of grey and greenish-grey, fine and coarse, rusty-weathering sandstone, with a three-feet bed of impure, concretionary or conglomeritic limestone dip N. 85° W. < 50°, associated with finely laminated shales. Grey sandstone occurs occasionally on the beach between River Moulin and Seal Cove; whilst further west, rusty-weathering and reddish sandstone dips inland and forms rocky barrens. Where the rock is not exposed on the shore it is not necessary to go far inland to find it. Above tidewater the south branch of River Moulin is generally low and swampy, flowing in ponds and creeks, through a barren, but occasionally cutting through light-grey and bluish sandstone and grit, sometimes with small cavities on the surface from which some soft substance has weathered out.

Seal Cove.

Rocky land.

Near Black River, on West Bay, reddish and grey argillaceous shales occur, and many outcrops of limestone, plaster and conglomerate are cut by the brooks of the neighborhood. At the mouth of the river, on the eastern bank, red conglomerate, composed of the ruins of the underlying felsites, is in place. On the shore is an exposure of white gypsum with dark streaks. In the millbrook which enters from the west, dark-bluish, thick-bedded, compact limestone is associated with white and grey plaster, light-grey sandstone and reddish argillaceous shale. Just below the road to the mill, the following descending section is presented:

Limestone and gypsum.

	FEET.	INCHES.
1. Grey, greenish and reddish argillaceous shale. Thickness indefinite	10	0
2. Grey and bluish-grey argillaceous shale, with thin, harder, calcareous bands, nodular masses, and vugs full of calcspar	9	0
3. Green crumbling shale	40	0
4. Red and grey mottled shale	7	0
5. Grey shale with a few spots of red	18	0
6. Grey, more coherent and harder argillite	7	0
7. Bluish, crumbling, soft argillite	7	0
8. Grey, fine sandstone or sandy argillite	13	0
9. Occasional exposures of red and greenish, crumbling, micaceous sandstone, grey, reddish and greenish, ripple-marked, arenaceous and argillaceous shale, with a somewhat variable westerly and north-westerly dip. These rocks continue as far as the Grandique road	..	..
Total thickness	111	0

Below this road, shales and flags of grey, bluish and reddish colors, often calcareous, are succeeded by reddish and grey compact porphyritic felsite with veins and grains of quartz, overlaid by a conglomerate formed of pebbles of this rock. In the brook, further down, conglomerate prevails, overlaid at one point by a bluish-grey limestone full of broken shells, in thick and thin beds. It is fourteen feet thick, and overlaid in turn by light-grey coarse grit. Small calcspar veins run at right angles to the bedding or in the planes of jointing. The dip is here N. 10° W. $<$ 85°. Still further down, conglomerate and crumbling argillaceous shale are associated with bands of nearly compact sandstone; and at George Murray's, where the stream ceases to be navigable for boats, gypsum is met with. About ten years ago a landslide blocked the river at this point and forced it into another channel. Lower down, a conglomerate is on the right bank, while on the left, salt springs occur.

Precambrian rocks in Black River.

Limestone.

Landslide.

On the shore road from the head of West Bay to Ross Creek, barrens abound, the country being underlaid by bluish shale and fine sandstone, probably as far as Ross Creek, where syenite comes to the road and is overlaid on the shore by fine sandstone, conglomerate and limestone. In Cameron Brook bluish shale and flaggy, micaceous, argillaceous sandstone, jointed into rectangular blocks, dip S. 48° W. $<$ 5°, and contain a few minute *Naiadites*. Higher up, grey and greenish, fine, jointed, nearly compact limestone with north and east joints, ripple-marked, flaggy and broken by lines of bedding and jointing into rectangular blocks a foot and a half by a foot square and three inches thick, is associated with red and green, mottled, fine sandstone and shale.

Contact of carboniferous and precambrian at Ross Creek.

Fossils.

On the eastern shore of Floda Island are many blocks of gypsum. The Crammond Islands are low and the soil good; the central one is inhabited and cultivated.

Islands of West Bay.

3rd Syncline or Basin.—Excellent exposures are found on the outer shores of Inhabitants Basin, where all the long parallel points and islands are on the strike of the hard grey sandstones composing them. At the mouth of Coal Brook, near Morash's, grey, rusty-weathering, fine sandstone, thin-bedded and full of impressions of calamites and other plants, dips about N. 24° W. $<$ 30°. Similar rocks, affording little variety, are seen in the cliffs to the southward, the angle of dip being always high, though somewhat variable. They strikingly resemble the millstone grit of the Sydney coalfield. Occasionally, as on the western point of Rabbit Island, the sandstone is argillaceous and ripple-marked; and in some places the beds are coarse, as on the small island between Evans and Rabbit Islands. Lenticular patches of calcareous conglomerate occur in the sandstone on the south

Inhabitants Basin.

Coal Brook.

Evans and Rabbit Islands.

shore of Rabbit Island, with prostrate trees in abundance, the bark of which has become transformed into coal. Near the western end of Evans Island, sandstone of the same character dips N. $<$ 38°, whilst on the western point are large blocks of gypsum from a bed apparently overlying, which is probably identical with that of Little River, Freeman Island and the small island to the westward. Coal is stated to occur on the south side of Freeman Island.

Coal reported.

Coal Brook displays contorted shales and sandstones, together with small seams of coal which will be described elsewhere. In White Brook many outcrops occur of light-grey, coarse and fine sandstone, and argillaceous shale, sometimes carbonaceous, with variable dip. On the lake from which the brook flows, pieces of sandstone are seen. On the track from Rory McDonald's to McMillan Lakes, indian-red, fine, argillaceous, micaceous sandstone occurs, and on one of these lakes is a doubtful exposure, perhaps belonging to an unconformable upper formation. The Chapel Brook shows fine cliffs of grey sandstone with calamites, dark-bluish, soft, argillaceous shales, sometimes brightly polished between the laminæ, and approaching impure limestone in composition, unfossiliferous, and somewhat coherent, but less so than the shales of Dorton's bridge. These are precisely like the shales seen in the large brooks which cross the River Inhabitants road between McLeod's and Long Stretch bridges.

White Brook.

Chapel Brook.

Near the mouth of this brook, on the shore, a small seam of coal is reported to occur containing, according to Mr. McBean, fifteen or eighteen inches of coarse coal and shale. A pit was sunk sixty-six feet at the road, but struck no coal.

Coal reported.

Shaft.

Blocks of grey and reddish sandstone, grit and conglomerate abound on the roads down the right bank of River Inhabitants below McLeod's bridge, and an outcrop of fine sandstone occurs near the end of the mines road, with purplish, reddish and grey shale. Pieces of sandstone and argillaceous shale occur also on the mines road between Hawkesbury and River Inhabitants, and on all the other roads of this region, the country being exceedingly rocky. On the banks of River Inhabitants, below McLeod's bridge, laminated, greenish-grey, purplish and reddish, argillaceous, waving, fine, ripple-marked sandstone, grit and conglomerate, containing fragments of plants, have a south-easterly dip at the rapids and elsewhere. Lower down, on the left bank, grey, greenish and purplish, false-bedded and flaggy sandstones are interstratified with a layer of grey, concretionary, calcareous rock, which also appears at the mouth of the millbrook. Broken sandstone banks occur lower down. In the millbrook above the post road to the basin, a few outcrops of reddish-grey sandstone are met with, succeeded by cliffs of grey, rather massive, rusty-weathering, fine sand-

McLeod's bridge.

River Inhabitants.

stone, with a variable dip. Rectangular joints run parallel with the bedding and across it. There are also outcrops of fine or compact, greyish-white, or impure limestone very calcareous, micaceous sandstone decomposed into hollows and knobby reefs. Above the winter road, grey and greenish sandstones have a westerly dip, and in a branch flowing from the St. Peters road, the dip is about north.

In both branches of Kemp Brook, immense cliffs of reddish sandstone and argillaceous shale appear above the St. Peters road, and in Ferguson Brook fine, grey, micaceous sandstone forms a fall sixteen feet high. In a small brook on the right bank, at J. Mack's, near the mouth of the river, reddish and greenish argillaceous shale dips N. 86° E. $<$ 12°; and on the left bank, nearly opposite, indian-red, fine, argillaceous, micaceous, shaly sandstone is associated with impure concretionary limestone. **Kemp Brook.**

On the shore of Inhabitants Basin, near the post-office at Walker's, greenish-grey and reddish argillaceous sandstone is met with. Blocks of this sandstone also occur on the roads and tracks about Little River coal mine, much of the country being barren or half-barren; and the same remark holds good of the region to the southward. At the mouth of the river is said to be an exposure of gypsum, and this has been found in many places higher up, as shown on the map. **Little River mine.**

Above the shore road in Little River, blocks of grey and greenish, coarse and fine, flaggy sandstone occur; and near the tramway bridge this rock is in place with a dip S. 34° W. $<$ 78°. A little higher, the strike is N. 60° W., vertically. In the western branch no rocks are met with above the mines road for a considerable distance, although blocks of reddish and grey sandstone are numerous, and the soil is clayey and often reddish. In the eastern branch, just above the mines road, at the first turn, reddish sandstone and argillaceous shale strike S. 71° E., vertically. Higher up, past the first pits, grey rusty sandstone, marked with plants, strikes about S. 67° E., with a slight dip upstream, succeeded by indistinct exposures of rocks like those of Caribacou—dark and greenish shales, underclay, with much coaly matter. Then comes a cliff of grey and greenish-grey rusty sandstone, with a moderate easterly dip; followed by rocks dipping S. 40° E. Not far above these are occasional outcrops of sandstone and shale, after which a light and dark-grey bituminous limestone, more or less concretionary, with calcspar crystals and rusty spots, of no great thickness, strikes along the bank. Higher still, greenish and grey calcareous shales, well exposed, dip S. 60° W. $<$ 70°. In a tributary not much further up, grey, red and green shales appear with a more moderate north-easterly dip. The high angle of dip in the vicinity of the coal **Little River.** **Coal.** **Limestone.**

Fault. mine is probably due to a fault, a supposition still further strengthened by the attitude of the limestone and gypsum on McVicar's farm near the St. Peters road. This is a down-throw on the west. From McVicar's the limestone has been traced two miles northward, where it is covered by higher strata or interrupted by a fault. It is dark-bluish, bituminous and fossiliferous and runs in mounds and ridges with gypsum.

Above the St. Peters road, Little River exhibits frequent exposures of grey, greenish and reddish, rusty, fine sandstone and shale, full of plants, as far as the Big Brook road. Occasional outcrops of sandstone also occur in the brooks about McIntyre Lake and over the whole surface of the country. North of the lake is an outcrop of shale, containing *Naiadites* and indistinct markings of plants.

McIntyre Lake

Seacoal Brook. In Seacoal Brook, above the shore road, fine, argillaceous, micaceous sandstone is again met with, succeeded, higher up, by a dark, bluish-grey variety, sometimes shaly and streaked with iron-rust. At the crossing of the new road, rocky barrens are formed by thick-bedded sandstone, which is also seen around Landrie Lake.

Below the road the brook comes to tidewater in a rocky gorge, showing reddish and grey fine sandstone. On the left bank, below the confluence of a small brook, the following vertical or nearly vertical strata are exposed, striking N. 67° E.:

SECTION IN SEACOAL BROOK.

	FEET.	INCHES.
1. Greenish and bluish argillaceous shale	9	0
2. Reddish and brown " "	3	0
3. Greenish " "	3	0
4. Bluish and greenish, papery, argillaceous shale	9	0
5. Reddish sandstone	1	6
6. Brown and purplish, micaceous, argillaceous shale	12	0
7. Bright-green argillaceous shale	2	0
8. Bluish and greenish argillaceous shale with harder bands, passing into dark-bluish argillaceous shale, like that of Hawkesbury	15	0
9. Greenish and bluish argillaceous shale in the small brook	10	0
10. Greenish, more friable, argillaceous shale	7	0
11. Greenish and bluish, more coherent, argillaceous shale	5	0
12. Reddish, micaceous, arenaceous shale with greenish bands, passing into sandstone	3	6
13. Reddish and greenish micaceous sandstone	10	0
14. Brown argillaceous shale with green streaks and sandstone bands	105	0
15. Bright-greenish argillaceous shale	4	0
16. Reddish argillaceous shale with sandstone bands. Forms the waterfall below the bridge	7	0

17. Similar rocks, indistinctly seen, extend to the bridge, and below the fall are seen beyond the first point, where the pond widens. They are again met with in an adjacent brook, dipping steeply S. 23° E., and apparently associated, higher up, with dark-bluish argillaceous shale containing thin bands of limestone	..	..
Total thickness	206	0

On the shore twenty-seven yards north of the bridge, at the mouth of the brook in which the mine is situated, the following strata are exposed in ascending order, the dip being S. 13° W., nearly vertical and overturned: Seacoal Bay.

SECTION AT SEACOAL BAY.

	FEET.	INCHES.	
1. Dark shale and underclay	15	0	
2. Coal; thickness not seen but said to be	4	0	
3. Black shale full of *Naiadites*, *Cythere*, fish remains and *Spirorbis*, with bands of greenish shale and thin, nodular layers of ironstone	48	0	Shells and ironstone.
4. Greenish argillaceous shale with layers of ironstone half an inch thick and downward in the lower part	23	0	
5. Greenish-grey rusty sandstone	3	0	
6. Greenish argillaceous shale	2	6	
7. Greenish-grey flaggy and shaly sandstone	3	6	
8. Greenish argillaceous shale	3	0	
9. Black shale, very coaly and coherent in places, but passing into ordinary dark shale	10	0	
10. Greenish-grey, fine, argillaceous shale	1	6	Carbonaceous shale.
11. Black or dark shale as before	12	0	
12. Greenish-grey argillaceous shale, in part very coherent	7	0	
13. Measures concealed	6	0	
14. Dark coaly shales	2	6	
15. Measures concealed, with occasional outcrops of greenish crumbling shale	18	0	
16. Bands of grey, coaly, flinty sandstone and shale	20	0	
17. Measures concealed	24	0	
18. Dark shale, succeeded by greenish argillaceous shale, with small layers of ironstone; not well seen	17	0	
19. Measures concealed	..	..	
Total thickness	220	0	

Between 18 and the next brook to the northward, a few blocks of conglomerate are met with.

At the eastern corner of Seacoal Pond, on the shore, greenish sandstone, possibly in place, seems to dip N. 20° E. < 55°; but the outcrop is obscure. A short distance further east, sandstone, full of plants,

has a similar dip, also very obscure. Beyond this, no rocks are seen as far as Malcolm's wharf, near which greenish-grey, coherent, fine, glistening sandstone, about one hundred feet thick, dips N. 38° E. < 80°. Eastward for 170 feet no rocks are met with; then grey and bluish-grey, coarse, rusty sandstone, false-bedded, with markings of plants, strikes about N. 18° E., and is about eighty feet thick. For 650 feet no rocks are seen, and those next met with display another dip N. 15° W. < 75°, but contorted. A fault is near this spot, but that the first of the following series belong to the south-east side of it is not certain. If they do the sequence is all ascending:

Fault.

SECTION OF CARBONIFEROUS ROCKS AT CARLETON HEAD.

		Feet.	Inches.
	1. Red and greenish argillaceous shale with hard bands; also bluish-grey, contorted, areno-argillaceous shale smoothly polished on the surface. A great deal of calcspar in the bedding. The hard bands are sometimes concretionary and calcareous. Contains a six-feet bed of greenish-grey, flinty, sparkling, broken, quartzose sandstone or quartzite	220	0
Quartzite underclay.	2. Greenish and grey, fine, compact, flinty sandstone, full of broken plants, pyritized and carbonized, and in part resembling underclay	25	0
	3. Reddish, purple and greenish mottled shale; strike N. 61° E.	40	0
Iron ore.	4. Alternations of rusty, greenish, grey and reddish flinty sandstone and thin bands of shale, full of plants and like the sandstone of Grant Point. Much brightly polished hematite in the joints. Slickenside grooves run about S. 65° E. < 15°; the dip is obscurely N. 25° W	50	0
	5. Reddish and greenish argillaceous shale	25	0
	6. Measures concealed	90	0
	7. Reddish and grey sandstone	3	0
	8. Measures concealed	50	0
	9. Grey and greenish fine sandstone, with a few argillaceous bands	160	0
	10. Measures concealed	20	0
Fault.	11. Grey sandstone. Here in a distance of 450 feet going eastward, the strike changes from S. 65° W. to S. 60° E., the dip being inland	120	0
	12. Measures concealed	10	0
	13. Grey sandstone	46	0
Ironstone.	14. Greenish argillaceous shale, with a few ironstone balls	45	0
	15. Greenish argillaceous shale, not well seen, sometimes rough and concretionary	60	0
	16. Measures concealed	40	0
	17. Grey thick-bedded sandstone, striking S. 52° E	40	0
	18. Evenly bedded argillo-arenaceous shale	25	0
	19. Greenish argillaceous shale, not well seen	5	0

20. Greenish and reddish argillaceous shale with harder bands...	22	0	
21. Reddish-grey concretionary or conglomeritic limestone, one to three feet..	2	0	Concretionary limestone.
22. Mottled red and green rocks. Dip N. 20° E. < 45°.........	78	0	
23. Greenish, grey and reddish concretionary limestone or conglomerate..	1	0	
24. Green flaggy sandstone..	1	6	
25. Conglomeritic limestone and sandstone mixed.............	2	9	
26. Reddish, greenish and purple mottled argillaceous shale.....	3	9	
27. Grey rusty conglomerate, full of coaly matter, plants and *Stigmaria*..	2	6	Underclay.
28. Grey and bluish-grey fine sandstone, broken and jointed, full of rusty spots and concretions, often spherical. Becomes more shaly and false-bedded at top............	36	0	
29. Bluish areno-argillaceous shale, passing into sandstone......	4	0	
30. Sandstone, passing into arenaceous shale..................	3	0	
31. Rusty concretionary, calcareous band; local...............	0	9	
32. Grey, rusty, thick-bedded, jointed sandstone; prostrate trees; concretions. Passes into shale.....................	35	0	Prostrate trees.
33. Reddish sandstone, the lower part calcareous and concretionary. Thickness indefinite.........................	18	0	
34. Red gypseous marl forming a high bank; nodules of reddish and white, fibrous, crystalline gypsum, with blocks of whitish gypsum, often porphyritic and containing limestone nodules. Not well seen. Dip N. 14° E. <45°. Carleton Head, from which the French are said to have obtained plaster..................................	106	0	Gypsum.
35. Greenish-grey, waving and contorted areno-argillaceous shale, dipping N. 7° E. < 45°.......................	39	0	
36. Measures concealed. Traces of bright red marl............	163	0	
37. Greenish-grey waving sandstone...........................	4	0	
38. Measures concealed..	..	..	
Total thickness...........................	1596	3	

The rocks of this section are unlike those between Bear Island and Plaster Cove, and are probably, therefore, higher. Whether the gypsum of Carleton Head is the same as that which overlies the coal at Little River is doubtful.

About 180 feet further east the dip is reversed, and small reefs of greenish-grey sandstone and argillaceous shale, with prostrate trees and concretionary masses of limestone, dip S. 10° E. < 30°. The appearance of blocks of gypsum on the beach soon afterward, seems to indicate a small fault or syncline. Gypsum.

Between Carleton Head and the next brook to the eastward, blocks of sandstone abound, with others of dark limestone. On the eastern side of the point, on the right bank of Little River, is a large quantity of bright greenish clay.

The shore between Seacoal Bay and Plaster Cove presents very interesting exposures of these rocks, and the following sections have been measured, beginning at the ferry-wharf (Emery's) north of Hawkesbury.

SECTION OF STRATA NORTH OF EMERY'S WHARF, HAWKESBURY, IN DESCENDING ORDER.

		FEET.	INCHES.
1.	Measures concealed	113	0
2.	Purplish and reddish-grey, micaceous, fine, friable argillaceous shale, flecked with green	4	0
3.	Reddish-grey sandstone with dull greenish spots	1	4
4.	Reddish-grey, crumbling argillaceous shale	3	6
5.	Reddish-grey sandstone	0	8
6.	Reddish-grey, argillaceous shale, with green streaks and blotches. Passes into sandstone	7	0
7.	Reddish-grey, friable, arenaceous shale, with bands of impure limestone	5	10
8.	Reddish and greenish-grey, calcareous, very coherent, fine sandstone, passing into arenaceous shale	1	9
9.	Reddish argillo-arenaceous shale	1	3
10.	Greenish-grey, rough argillaceous shale	1	3
11.	Dark, greenish-grey, crumbling argillaceous shale	10	0
12.	Bluish-grey, very fine calcareo-argillaceous sandstone	0	10
13.	Bluish-green, micaceous, calcareo-argillaceous shale	1	6
14.	Fine sandstone and arenaceous shale irregularly mixed. False bedding	2	4
15.	Greenish-grey and rusty argillaceous and arenaceous shale	2	0
16.	Very coherent, fine sandstone, thick-bedded, flaggy and shaly, grey and rusty, passing in places into grey concretionary limestone, like that near McLeod's bridge, River Inhabitants (P. 70 F) (Concretionary limestone.)	4	11
17.	Reddish argillaceous and arenaceous shale	2	9
18.	Reddish argillaceous shale, not well seen. Dip N. 71° E. < 47°	7	3
19.	Reddish, waving, argillaceous shale with sandstone bands	6	6
20.	Measures concealed. Occasional red bands; about	66	0
21.	Grey coarse sandstone	1	0
22.	Measures concealed	4	0
23.	Reddish argillaceous shale	3	0
24.	Measures concealed	3	0
25.	Reddish-grey sandstone	1	6
26.	Measures concealed	3	0
27.	Greenish-grey argillaceous shale with carbonized plants	2	3
28.	Measures concealed	1	6
29.	Greenish-grey, fine, coherent sandstone	5	0
30.	Reddish, fine waving sandstone	1	6
31.	Measures concealed	8	4
32.	Crumbling argillaceous shale	5	2
33.	Reddish, crumbling, argillaceous sandstone, with small patches of nodular, impure, micaceous limestone (Concretionary limestone.)	2	0

34. Measures concealed	2	6
35. Reddish, crumbling, argillaceous shale	3	6
36. Reddish shaly sandstone, with green marks	1	2
37. Measures concealed. Dip S. 63° E. < 43°. It is assumed that the thick coherent sandstone of Grant Point is in the concealed interval, instead of striking the shore south of Emery's wharf. If such is not the case, some of the estimates of thickness here given are too great	136	0
38. Reddish-grey, fine, shaly sandstone	12	0
39. Greenish-grey and red argillaceous shale	3	0
40. Coherent sandstone	0	9
41. Measures concealed	3	0
42. Red shaly sandstone	1	3
43. Measures concealed	1	6
44. Reddish argillaceous shale	4	10
45. Measures concealed	3	8
46. Reddish argillaceous shale	30	0
Total thickness	488	1

Then follow these beds on Grant Point in reverse order to 40:

Section at Grant Point.

	Feet.	Inches.	
1. Coherent sandstone (No. 40)	0	9	
2. Measures concealed. Dip N. 78° E. < 46°	80	0	
3. Greenish argillaceous shale	1	0	
4. Friable, argillaceous, shaly sandstone	5	0	
5. Reddish-grey, shaly sandstone, with small concretions of grey compact limestone; also calcspar	7	6	
6. Measures concealed	10	0	
7. Reddish, crumbling, argillaceous shale	7	6	
8. Reddish shaly sandstone	0	1	
9. Red, crumbling, argillaceous shale	4	3	
10. Reddish-grey, shaly sandstone	1	3	
11. Reddish argillaceous shale	8	10	
12. Measures concealed. Grant Point	7	0	
13. Grey, fine, flaggy and shaly, jointed sandstone, with fragments of plants; quartz crystals in joints. A small fault, a downthrow of six inches on the east side along an open joint lined with quartz	11	2	Small fault.
14. Grey flinty sandstone, full of broken plants	3	3	Plants.
15. Dirty, soft and hard, broken, carbonaceous and graphitic argillaceous rock	0	3	
16. Grey flinty sandstone	5	0	
17. Dark-blue argillaceous shale	0	4	
18. Grey thick-bedded sandstone with druses of quartz in the joints, sometimes rusty, shaly and crumbling. Lenticular patches of shale	23	8	
19. Measures concealed, but probably the same as 18	7	9	

	20. Grey, fine, coherent sandstone in thick and thin beds.......	11	6
	21. Reddish fine sandstone with a green layer	1	2
	22. Reddish-grey and grey, fine, coherent sandstone, curiously jointed, the joints being never more than a few inches apart..	6	0
	23. Dark-grey argillo-arenaceous shale........................	1	6
	24. Reddish-grey, waving shaly sandstone......................	2	3
	25. Reddish argillaceous shale with plants....................	4	3
	26. Rusty and cream-colored, crumbling and compact sandstone, full of broken plants, rootlets and *Stigmaria*.........	5	3
Underclay.	27. Whitish-grey quartzite in thick layers, drused with quartz. Becomes reddish at top..........................	8	7
	28. Alternations of reddish arenaceous shale and quartzite......	0	11
	29. Reddish, bluish and greenish-grey crumbling argillaceous shale..	13	0
	30. Reddish fine sandstone..................................	0	6
	31. Reddish areno-argillaceous shale.........................	4	7
	32. Reddish, compact, somewhat soft sandstone................	0	7
	33. Reddish argillaceous shale...............................	0	4
	34. Reddish argillaceous sandstone...........................	1	0
	35. Reddish argillaceous shale with harder lenticular layers.....	6	9
	36. Reddish, fine, argillaceous, micaceous sandstone in thick layers; threads of calcspar. Shaly at top............	15	4
Underclay.	37. Rusty, somewhat coherent sandstone, full of broken plants and doubtful rootlets. Runs into quartzose sandstone and into a concretionary rock......................	3	5
	38. Grey and bluish-grey, jointed, flinty sandstone. Probably No. 9 of next section	14	0
	39. Bluish-grey, flaggy, argillaceous rock....................	9	6
	40. Light, bluish-grey coherent sandstone.....................	1	0
	41. Bluish-grey argillaceous shale...........................	2	6
	42. Light-grey flinty sandstone..............................	2	7
	43. Bluish-grey, argillaceous and arenaceous shale and sandstone, with hard bands..............................	7	6
	44. Reddish-grey and greenish, micaceous, argillaceous sandstone, with a greenish tinge in places. Passes into shale....	7	0
	45. Reddish-grey, flaggy, micaceous sandstone.................	5	6
	46. Reddish, finer, argillaceous shale and sandstone............	3	0
	47. Greenish-grey and red, crumbling, argillaceous shale........	2	10
	48. Measures concealed.......................................	5	0
	49. Reddish-grey quartzose sandstone.........................	2	3
	50. Reddish-grey argillaceous shale..........................	3	0
	51. Red and greenish sandstone...............................	0	4
	52. Reddish argillaceous shale. Some of these rocks are rippled; others contain fragments of plants.................	4	3
Plants.	53. Measures concealed by Emery Pond.........................	..	..
	Total thickness..	341	9

Immediately beyond the pond these rocks are again repeated in descending order, as follows:

SECTION OF CARBONIFEROUS STRATA BEWEEN EMERY POND AND PLASTER COVE.

		FEET.	INCHES.	
1.	Reddish argillaceous shale. Dip N. 86° E. < 46°	205	0	
2.	Reddish coherent rock, with green blotches	1	8	
3.	Reddish-grey coherent sandstone	2	0	
4.	Reddish argillaceous shale, with sandstone bands and greenish streaks	28	0	
5.	Reddish argillaceous sandstone, with greenish patches and shaly layers in the lower part	7	6	
6.	Alternations of reddish and greenish argillaceous shale and sandstone	3	10	
7.	Greenish argillaceous shale, with layers of sandstone	1	7	
8.	Grey, fine, crumbling, argillaceous sandstone, passing into shale	4	8	
9.	Grey flinty sandstone, rusty and full of quartz in the joints; dark manganese stains; broken plants. Probably No. 38 of the preceding section	32	8	Plants.
10.	Reddish, purplish and greenish, crumbling, argillaceous rock, with small nodules	25	0	
11.	Grey, shaly and thick-bedded sandstone, with rusty spots; quartz crystals in the joints	7	8	
12.	Purplish, crumbling, argillaceous shale, with small green patches. Harder bands towards the bottom	32	0	
13.	Reddish sandstone, with grey, micaceous, nodular spots	3	10	
14.	Greenish-grey argillaceous shale	2	6	
15.	Grey and greenish-grey arenaceous shale, with rusty spots; passes into waving, micaceous sandstone, full of broken plants	19	2	
16.	Greenish and purplish argillaceous shale	15	0	
17.	Greenish-grey, rust-spotted, argillaceous and arenaceous shale, with sandstone bands, passing at the bottom into sandstone	11	6	
18.	Rusty-grey crumbling underclay, full of broken plants and rootlets	4	0	Underclay.
19.	Flinty, quartzose sandstone, with quartz crystals in the joints	7	8	
20.	Reddish shaly sandstone	4	6	
21.	Grey, flinty, micaceous sandstone	4	0	
22.	Reddish-grey sandstone, with greenish irregular layers	5	0	
23.	Grey fine sandstone with quartz in the joints	4	0	
24.	Dirty, greenish-grey, crumbling, argillaceous shale	5	6	
25.	Reddish and purplish, crumbling argillaceous shale, with layers of waving sandstone	25	0	
26.	Greenish, finely-bedded argillaceous shale, passing into shaly sandstone	18	6	
27.	Grey, slightly calcareous, micaceous shale and sandstone, with rusty spots; broken plants; quartz crystals in the joints	20	0	

	28. Reddish and purplish crumbling argillaceous shale, with green streaks and patches	34	3
	29. Reddish, flaggy, jointed, micaceous, fine sandstone, with green patches	1	10
	30. Greenish argillaceous shale	0	2
	31. Reddish and brown, crumbling, argillaceous shale, with green patches and small harder nodules	17	6
	32. Reddish-grey, flinty, quartzose sandstone, passing downward into grey, rusty, flinty sandstone, with bands of shale	33	0
	33. Reddish argillaceous shale, with sandstone layers	6	0
	34. Measures concealed by the beach at the temperance hall	210	0
	35. Reddish, crumbling, argillaceous shale with sandstone bands.	11	0
	36. Grey and reddish-grey, fine, thick-bedded sandstone; plants.	64	0
	37. Reddish-grey fine sandstone	2	2
	38. Reddish, crumbling, argillaceous shale, full of hard concretions at top	8	4
	39. Greenish argillaceous shale, passing below into sandstone	20	0
	40. Bright brown, crumbling, argillaceous shale, with green harder patches and layers of sandstone	24	0
	41. Greenish and reddish, very coherent sandstone	1	9
	42. Brownish, micaceous, argillaceous shale and sandstone, mixed	10	6
	43. Greenish and reddish sandstone and argillaceous shale in lenticular beds	8	6
	44. Dark greenish-grey argillaceous shale	0	9
Plants.	45. Grey, rusty-weathering, flinty, micaceous, quartzose sandstone, with quartz crystals in the joints; markings of plants.	17	6
	46. Measures concealed. Dip N. 86° E. < 45°	700	0
	47. Red and green, mottled, micaceous, areno-argillaceous shale.	8	0
	48. Greenish-grey flinty sandstone	2	6
	49. Indian-red, crumbling, argillaceous shale	3	6
	50. Brownish and greenish argillaceous shale, with bands of sandstone. Quartz crystals in the joints; calcspar veins and blotches	19	0
	51. Greyish-red quartzose sandstone	1	1
	52. Reddish argillaceous shale with green streaks which run in the bedding or joints, and probably originated after the deposition and consolidation of the beds	10	0
	53. Indian-red argillaceous shale and sandstone, streaked with veins of quartz and calcspar	3	10
	54. Reddish and greenish argillaceous shale and sandstone	16	0
	55. Indian-red argillaceous shale with greenish concretionary limestone	0	5
	56. Reddish, brownish and greenish, mottled, fine, argillaceous sandstone	1	9
	57. Measures concealed. Dip N. 82° E. < 40°	32	0
	58. Greenish and brownish, mottled, argillaceous shale, with concretions and thin bands of fine, coherent sandstone. The brownish shales are most abundant, the greenish occurring in thin layers or lenticular streaks	66	0

59. Reddish, coherent, fine sandstone, with vugs and threads of quartz and calcspar	11	0	Veins of quartz and calcspar.
60. Reddish-grey, jointed and broken sandstone, veined with quartz	8	0	
61. Measures concealed, probably reddish, crumbling, argillaceous shale	4	0	
62. Greenish-grey, waving, coherent sandstone with quartz veins in the joints	2	0	
63. Measures concealed, probably reddish argillaceous shale	6	0	
64. Reddish, crumbling, argillaceous shale, with layers of coherent sandstone	30	0	
65. Measures concealed. Occasional reefs of sandstone	58	0	
66. Reddish argillaceous shale	80	0	
67. Greenish argillaceous shale	2	6	
68. Reddish argillaceous shale with green blotches and sandstone layers	23	0	
69. Reddish coherent sandstone	2	9	
70. Brownish argillaceous shale	1	6	
71. Greenish argillaceous shale	4	0	
72. Brownish argillaceous shale	3	0	
73. Measures concealed. Dip N. 84° E. < 43°	57	0	
74. Greenish and bluish-grey, fine, coherent sandstone, with threads of quartz	23	0	
75. Measures concealed. Dip S. 82° E. < 44°	119	0	
76. Rusty-grey, shaly and thick-bedded, fine micaceous sandstone, often beautifully rippled; broken plants; quartz crystals in the joints	10	0	Plants.
77. Reddish argillaceous shale mixed in lenticular beds with greenish argillaceous shale. Bands of sandstone	16	0	
78. Greenish-grey very coherent sandstone, rippled and waved, rust-spotted and marked with broken, carbonized plants	15	0	
79. Brown argillaceous shale	8	0	
80. Measures concealed. Mouth of a small brook	13	0	
81. Bright brown shale with greenish and reddish harder bands.	14	6	
82. Reddish sandstone	2	10	
83. Bright green, reddish and brown argillaceous shale	84	0	
84. Dirty greenish and reddish, micaceous, more arenaceous shale, crumbling and containing a few harder concretions	36	0	
85. Measures concealed. Dip S. 87° E. < 50°	368	0	
86. Greenish-grey, reddish and brown sandstone and shale	20	0	
87. Grey and greenish sandstone	8	3	
88. Bright indian-red, crumbling, argillaceous shale	5	0	
89. Reddish and greenish sandstone and argillaceous shale with a few brighter bands, full of quartz-films in the joints	30	0	
90. Bottle-green sandstone with films of calcspar and quartz	7	10	
91. Grey, compact, calcareous sandstone	0	6	
92. Reddish, greenish and bright brown sandstone and shale, with minute films of quartz and calcspar	74	8	
93. Grey and greenish-grey, coherent, fine sandstone and argil-			

	laceous shale, jointed in the direction of the bedding..	16	7
	94. Reddish argillaceous shale with streaks of green............	7	9
Dark calcareous shales with fossils.	95. Greenish and grey argillaceous and arenaceous shale and sandstone, with thin, rusty, calcareous layers.........	7	10
	96. Dark bluish-grey and grey evenly-bedded shales with lenticular layers of limestone, containing numerous small *Naiadites* and entomostracans. *Leaia Leidyi* was found in loose pieces of rock apparently derived from this bed..	13	2
	97. Greenish, harsh, micaceous, argillaceous rock	4	9
	98. Reddish and greenish-mottled, beautifully rippled sandstone and argillaceous shale, with thin layers of limestone at bottom...:..................................	32	2
	99. Bright red argillaceous shale..........................	2	1
	100. Greenish, reddish and bluish argillaceous shale and sandstone; broken plants............................	11	8
	101. Reddish, greenish and bright indian-red argillaceous shale and sandstone, with veins of quartz in the joints, sometimes an inch and a half thick......................	161	4
	102. Greenish-grey argillaceous shale and sandstone, with a few red bands. Passes into a very coherent, grey or rusty sandstone, with plants..........................	43	6
	103. Brown and indian-red argillaceous shale with lighter bands..	13	9
	104. Reddish and greenish argillaceous sandstone with greenish blotches and layers of shale......................	12	6
	105. Bright brown, crumbling, argillaceous shale................	5	2
	106. Greenish and grey, fine, rippled sandstone, full of quartz and passing into argillaceous shale......................	31	0
	107. Reddish jointed sandstone, full of quartz. Passes downward into brown and reddish argillaceous shale, with thin bands of rusty, coherent sandstone...................	38	0
	108. Grey, greenish and rusty sandstone, with broken plants.....	5	9
	109. Dark and light-bluish, evenly-bedded argillaceous shale....	4	2
	110. Greenish and greyish, more crumbling argillaceous shale....	6	1
	111. Reddish, greenish and bluish argillaceous shale............	15	9
Fossils.	112. Bluish and grey, evenly-bedded, fine shales, full of *Modiolæ* or small entomostracans...............................	57	9
	113. Greenish and greyish, less shaly rocks, with coherent layers. Small, grey calcareous beds........................	45	7
	114. Light greenish-grey, harsh, flaggy or thick-bedded rocks, with films of quartz and calcspar.........................	11	0
	115. Bluish-grey, evenly-bedded, argillaceous shale, with thin bands of limestone....................................	9	3
	116. Greenish-grey crumbling rocks, succeeded by fossiliferous shales.		
	117. Reddish and greenish, mottled, crumbling, argillaceous shale	38	0
Fossils. Veins.	118. Dark bluish argillaceous shale containing entomostracans; thin bands of sandstone and limestone; quartz and calcspar veins..	64	6

119. Greenish and grey, harsh, crumbling, argillaceous shale......	6	0	
120. Dark bluish shales holding entomostracans................	3	0	
121. Greenish, fine, rippled sandstone........................	7	0	
122. Dark bluish, fine, rusty shales	2	6	
123. Greenish-grey argillaceous shale	4	0	
124. Black or dark-bluish argillaceous shale, sometimes papery...	15	9	
125. Greenish and bluish, fine, nodular argillaceous shale, with thin bands of limestone..............................	51	6	Limestone.
126. Greenish and reddish argillaceous shale and sandstone, passing in places into dark shales........................	105	0	
127. Bright red, reddish and greenish, argillaceous, friable and harder rocks..	150	0	
128. Dark bluish and greenish-grey micaceous shale, with broken plants..	11	10	Plants.
129. Greenish-grey argillaceous rock, with rusty harder bands....	15	6	
130. Bright red, reddish and greenish, crumbling, argillaceous shale. Some layers are full of greenish nodules......	121	0	
131. Measures concealed...	27	0	
132. Reddish and greenish sandstone.............................	28	0	
133. Bluish-grey argillaceous shale.............................	12	6	
134. Greenish argillaceous shale, full of concretions	7	7	
135. Dark shales with hard, rusty bands.......................	29	6	
136. Greenish-grey sandstone, full of blotches of quartz..........	7	9	
137. Greenish and bluish, coherent, argillaceous shale...........	14	6	
138. Brown argillaceous shale, with greenish layers and bands of sandstone..	80	0	
139. Dark argillaceous shale, with hard bands..................	25	0	
140. Greenish argillaceous shale	8	0	
141. Red and greenish argillaceous shale, with hard bands.......	121	0	
142. Measures concealed. Dip S. 87° E. < 53°.................	170	0	
143. Greenish sandstone reef....................................	15	0	
144. Broken land soon succeeds, probably underlaid by plaster and limestone. Assuming that the rocks dip as before, there is to the small brook on the south point of Plaster Cove a thickness of..........................	754	0	
145. The distance from this brook to the top of the limestone is about 725 feet. Assuming that the angle of dip is 60° and that the strata are not crumpled, this will give a thickness of 628 feet, the greater part being occupied by gypsum, limestone and gypseous marl. One bed of the gypsum is estimated by Dr. J. W. Dawson (Acadian Geology p. 392) as 150 feet thick.....................	628	0	
146. Limestone, described in Acadian Geology, p. 391 ; thickness indefinite	30	0	Devonian rocks
147. Flinty quartzite, sandstone and conglomerate (*Devonian?*) seen between Plaster Cove and McMillan Point.......	..	..	
Total thickness...........................	6102	5	

Between Emery's wharf and a point on the beach south of the cross

roads at Dominion wharf, a thickness of about 824 feet, is concealed with the exception of occasional bands of grey sandstone. Rocks are then again seen on the beach which perhaps represent the millstone grit. These are in ascending order as follows:

SECTION AT HAWKESBURY HARBOR.

		Feet.	Inches.
	1. Measures concealed between Emery's wharf and the shore east of Dominion wharf. Dip N. 75° E. < 53°. A few indistinct beds of grey sandstone	824	0
	2. Measures concealed	117	0
	3. Grey, flaggy and shaly sandstone, passing upward into reddish, shaly, crumbling sandstone	34	0
	4. Reddish and greenish argillaceous shale, not well seen	19	0
	5. Reddish sandstone	8	0
	6. Measures concealed	51	0
	7. Reddish sandstone and argillaceous shale	10	3
	8. Greenish-grey argillaceous shale and sandstone	5	2
	9. Dark bluish-grey crumbling shale	2	6
	10. Greenish-grey, nodular, argillaceous shale	3	9
	11. Dark bluish-grey, crumbling, papery shales	6	10
	12. Greenish-grey, crumbling, argillaceous sandstone	3	11
	13. Measures concealed	110	0
Plants.	14. Rusty-grey sandstone, false-bedded, with markings of plants. (No. 11 of next section)	61	9
	15. Measures concealed. Dip N. 64° E. < 57°	173	0
	16. Dark bluish-grey, crumbling, argillaceous shale	59	0
	17. Measures concealed	67	0
	18. Grey, very coherent sandstone	8	0
	19. Measures concealed	34	0
	20. Dark bluish argillaceous shale	4	0
	21. Greenish-grey sandstone	4	0
	22. Dark bluish, fine, argillaceous shale	7	0
	23. Grey impure limestone	0	10
	24. Dark bluish argillaceous shale, with bands of dirty limestone and rusty sandstone. Greatly contorted	61	0
	25. Measures concealed	11	0
	26. Grey sandstone	17	0
	27. Dark bluish shale, like 24	8	4
	28. Grey rusty sandstone	2	0
	29. Grey and bluish-grey argillaceous shale	7	6
	30. Light grey sandstone	1	9
	31. Bluish-grey argillaceous shale	5	0
	32. Light grey sandstone	1	3
	33. Bluish-grey, micaceous, argillaceous shale	4	6
	34. Light grey rusty sandstone	0	8
	35. Bluish-grey argillaceous shale	4	5
	36. Light grey, rusty, micaceous sandstone, jointed and broken, marked with plants	4	6
	37. Measures concealed	8	0

38. Bluish-grey argillaceous shale	6	3	
39. Light-grey waving sandstone	0	8	
40. Grey and bluish-grey argillaceous shale, with thin limestone bands. *Naiadites*	92	8	Shells.
41. Grey and bluish-grey, thin and thick-bedded, flaggy sandstone	21	6	
42. Grey and bluish-grey argillaceous and arenaceous shale	9	6	
43. Greenish, waving, micaceous, shaly sandstone	6	3	
44. Dark bluish argillaceous shale	3	11	
45. Light grey thick-bedded sandstone; broken plants	2	0	
46. Bluish-grey argillaceous and arenaceous shale, with thin bands of sandstone	11	9	
47. Grey sandstone; ripple marks at top	1	4	
48. Grey areno-argillaceous shale with thin bands of sandstone	12	5	
49. Light grey flaggy sandstone, with broken plants	3	11	
50. Grey and dark bluish-grey, argillaceous and arenaceous shale, with thin bands of sandstone	8	6	
51. Light grey sandstone	1	11	
52. Bluish and grey argillaceous shale	8	8	
53. Light grey, fine, flaggy and shaly sandstone, with minute veins of calcspar. One of these veins contains black and honey-colored zinc blende	5	5	Zinc blende.
54. Bluish-grey argillaceous shale	4	7	
55. Sandstone, in thin and thick beds	12	0	
56. Dark bluish argillo-arenaceous shale	2	6	
57. Calcareous sandstone	2	6	
58. Dark bluish argillaceous shale	10	6	
59. Flaggy sandstone and argillaceous shale	31	5	
60. Light grey sandstone	2	7	
61. Dark bluish argillaceous shale, with thin layers of sandstone, the latter usually waving or rippled. Toward the top the beds become more sandy. Fine impressions of fucoids	160	0	Ripple-marks: fucoids.
62. Measures concealed. Dip N. 53° E. < 54°	57	0	
63. Greenish argillaceous shale	3	0	
64. Greenish waving sandstone	2	0	
65. Bluish argillaceous shale	..	..	
66. Measures concealed to the middle of the bridge on the road at the head of the harbor	76	0	
Total thickness	2311	8	

Above those rocks lie grey sandstones and argillaceous shales, with occasional red bands. For about sixty-seven chains the angle of dip varies from 40° to 60°, then it becomes nearly vertical. This gives a thickness of about 3387 feet. Then comes an indefinite thickness of dark-bluish, black and grey argillaceous shale, with great bands of sandstone which form barrens. If no fault intervenes, assuming the

Strata above those of Hawkesbury Harbor.

angle of dip to be 75°, and the gypsum to begin at the small ponds near Little River, the distance is one hundred and forty chains, and the vertical thickness 8826 feet. All of this is then overlaid by the coal, gypsum and limestone of Little River.

Then follow the reddish strata occupying the country between Little River and the highest beds of the basin east of McLeod's bridge. The dip seldom exceeds 15°, the distance is about a mile, and the thickness probably less than 1350 feet.

Combining these sections, we have the thickness of carboniferous rocks in the region as follows:

Total thickness of carboniferous rocks.

	Feet.
1. From the highest beds seen at the syncline east of McLeod's bridge, to the gypsum of Little River	1350
2. Little River gypsum, limestone and coal, underlaid by dark shales and sandstones	8926
3. Grey sandstone with occasional red bands, as far as the bridge at the head of Hawkesbury Harbor	3387
4. Strata between Hawkesbury bridge and the highest rocks north of Emery Pond, as given in the section on p. 76	2195
5. Rocks between Emery Pond and Port Hastings, as in the section on pp. 79 to 83	6102
Total thickness	21960

On the south side of Hawkesbury Inlet the beds are repeated in descending order:

SECTION ON TUPPER POINT.

	Feet.	Inches.
1. Measures concealed from the bridge (No. 66 of last section.) Dip N. 53° E. < 54°	858	0
2. Bluish-grey, wrinkled, argillaceous and arenaceous shale, with thin bands of sandstone	10	0
3. Alternations of bluish-grey and greenish, fine, ripple-marked sandstone and shale	54	0
4. Ripple-marked sandstone, with some bands of shale	65	0
5. Measures concealed	10	0
6. Grey sandstone and shale	9	0
7. Measures concealed	9	0
8. Flaggy sandstone	4	0
9. Measures concealed	45	0
10. Greenish argillaceous shale and sandstone	4	0
11. Greenish and grey sandstone. (Probably No. 14 of next section)	58	0
12. Measures concealed. Dip N. 65° E. < 50°	608	0
13. Reddish and greenish argillaceous shale	10	0
14. Greenish, fine, crumbling, argillaceous shale	9	0

15. Grey and greenish-grey fine sandstone, spotted with broken, carbonized calamites and other plants. Certain rusty spots show traces of green copper carbonate..........	63	0	Carbonized plants. Copper ore.
16. Measures concealed. N. 65° E. < 55°....................	20	0	
17. Reddish and greenish-grey sandstone........................	10	0	
18. Measures concealed. Dip N. 60° E. < 51°................	23	0	
19. Sandstone..	6	0	
20. Measures concealed....................................	92	0	
21. Reddish and greenish flinty sandstone or quartzite, with concretionary conglomeritic patches....................	6	0	
22. Reddish argillaceous shale and sandstone..................	32	0	
23. Reddish coherent argillaceous sandstone..................	1	8	
24. Calcareous, concretionary, nodular sandstone..............	16	6	
25. Red, coherent, argillaceous rock..........................	13	6	
26. Measures concealed....................................	33	0	
27. Grey irregularly-bedded sandstone........................	48	6	
28. Measures concealed. Dip N. 54° E. < 52°................	38	0	
29. Greenish and bluish-grey, flaggy and thick-bedded rusty sandstone..	76	0	
30. Measures concealed....................................	314	0	
31. Grey, calcareous, concretionary sandstone, mixed irregularly with conglomerate and limestone; like that of Grant Point..	12	0	
32. Reddish, greenish and grey sandstone....................	36	0	
33. Measures concealed at the marine slip, but wherever seen consisting of red and purple sandstone and argillaceous shale. Dip N. 66° E. < 47°......................	387	0	Marine slip.
34. Alternations of reddish argillaceous shale and sandstone, with a few thin layers and blotches of green..............	249	0	
35. Reddish micaceous sandstone, irregularly bedded	36	0	
36. Measures concealed, except occasional reefs of mottled red and green argillaceous sandstone and shale; ripple marks	242	0	
37. Reddish or brown, micaceous, calcareous sandstone and shale, with greenish layers and blotches. Concretions of impure limestone..................................	33	0	
38. Brown sandstone and shale 1 foot to 2 feet 3 inches.........	1	8	
39. Greenish nodular sandstone 9 inches, passing into nodular limestone 1 foot 1 inch, and grey flinty sandstone 4 inches. Like the red beds generally, these measures are extremely variable..........................	1	1	
40. Alternations of brownish argillaceous shale and sandstone, principally the former..........................	13	0	
41. Reddish sandstone....................................	0	7	
42. Reddish argillaceous shale, with bright-green pipes. All the beds are more or less nodular, bright-green in places, and often well rounded by ice......................	4	0	
43. Alternations of reddish sandstone and shale................	6	0	
44. Greenish calcareous shale................................	0	2	

A fault running N. 29° E. throws these beds down two feet and a half to the south. Small fault.

45. Greenish-grey, impure, nodular limestone	0	6
46. Red or brown argillaceous shale with one or two thin layers of sandstone ; reddish limestone nodules	12	0
47. Reddish-grey sandstone	1	0
48. Reddish shale	3	0
49. Reddish shaly sandstone	3	0
50. Reddish argillaceous shale, with thin, hard, limestone layers and nodules	17	0
51. Greenish-grey argillaceous shale with lenticular layers and nodules	6	0
These are the lowest beds seen on Tupper (Stapleton) Point, where they are well exposed in the cliffs.		
Total thickness	3610	2

Half a mile south of Tupper Point, on the shore toward Bear Island, some of the beds of this section are again repeated in ascending order.

	FEET.	INCHES.
1. Reddish sandstone and shale. (No. 37 of last section)	33	0
2. Measures concealed. Dip N. 66° E. < 46°	44	0
3. Greenish-grey sandstone	10	0
4. Measures concealed	58	0
5. Mottled greenish and reddish, coherent, shaly and waving sandstone	12	0
6. Reddish and brown argillaceous shale	9	6
7. Reddish sandstone	1	9
8. Brown argillaceous shale	4	0
9. Reddish sandstone 6 inches to 1 foot 6 inches	1	0
10. Reddish argillaceous shale with greenish layers	8	0
11. Reddish and greenish mottled sandstone	1	6
12. Brown argillaceous shale with small greenish nodules and thin layers of sandstone	10	0
13. Greenish nodular limestone	..	4
14. Brown argillaceous shale and sandstone, including a green layer	14	0
15. Measures concealed. There is some doubt about the estimate, because no rocks are seen for four fifths of a mile and the dip changes in direction in that distance from N. 62° E. to N. 38° E	308	0
16. Reddish grey sandstone. Dip N. 38° N. < 40°	6	0
17. Occasional reefs of reddish and greenish sandstone and shale.	12	0
Total thickness	533	1

Peebles Point. On Peebles Point these strata should be repeated in reverse order, but no rocks are seen. Below the last mentioned bed (No. 17) there should be a thickness (Dip N. 15° E. < 45°) of 1832 feet; or, in

other words, the section should represent the strata for 1230 feet below the lowest rocks seen at Tupper Point (No. 51 of above section). Below this again is a thickness (Dip N. 23° E. $<$ 38°) of 468 feet to the top of the first bed of next section. It begins at a wharf n Peebles Cove, and is as follows in descending order.

SECTION OF STRATA FROM PEEBLES COVE SOUTHWARD.

		FEET.	INCHES.	
1.	Grey and greenish-grey rusty sandstone, sometimes flinty, sometimes crumbling	316	0	
2.	Reddish argillaceous shale	9	6	
3.	Measures concealed. Dip N. 34° E. $<$ 40°	19	0	
4.	Mottled, reddish and greenish, waving, flaggy sandstone	11	6	
5.	Light-grey and rusty sandstone with markings of plants	9	0	
6.	Measures concealed	5	9	
7.	Shaly and flaggy sandstone	5	6	
8.	Measures concealed	5	0	
9.	Fine arenaceous shale	3	6	
10.	Reddish, fine arenaceous shale	2	6	
11.	Measures concealed	16	6	
12.	Dark calcareo-argillaceous shales and flags	4	0	
13.	Measures concealed	2	9	
14.	Dark, fine argillaceous shale	11	6	
15.	Measures concealed, with occasional layers of dark calcareous shale, containing large masses or a bed of black earthy pyritous limestone full of encrinites and small shells; traversed by netted veins of calcspar	31	0	Limestone Shells.
16.	Greenish calcareo-argillaceous sandstone	2	0	
17.	Occasional outcrops of dirty, shaly limestone and black calcareous shale	60	0	
18.	Dark-bluish or black calcareo-argillaceous shale	8	0	
19.	Greenish and bluish-grey, micaceous, calcareous sandstone, passing into calcareous shale	13	4	
20.	Brownish and greenish argillaceous shale and sandstone	..	..	
21.	Measures concealed. Dip N. 30° E. $<$ 40°	75	0	
22.	Dark calcareo-argillaceous shale	33	0	
23.	Measures concealed by a shingle beach	202	0	
24.	Measures concealed. Large blocks of sandstone and conglomerate on the shore and rocky sandstone land on the line of section	334	0	
25.	Measures concealed by boulder clay, the bank being broken as if by landslides, and a good many blocks of dark limestone appearing on the shore. The estimate of the thickness assumes that the rocks still dip N. 30° E. $<$ 40° as far as the mouth of the small brook at the end of the road to Caribacou between Wright Point and Ship Point. This is somewhat doubtful, because at this brook the strata are vertical, striking N. 64° E., or have a northerly dip. There is a fault here	366	0	Fault.
	Total thickness	1266	4	

The general agreement of the beds of these sections with those between Hawkesbury and Port Hastings is remarkable. The dark shales (Nos. 15, 17 and 19) are probably those which contain *Leaia* near Plaster Cove.

The position of the following beds with relation to those just described is problematical. At 500 feet south of the little brook the dip is S. 62° E. < 75°; 200 feet further, S. 76° E. < 75°; immediately beyond, N. 68° E. < 75°; 400 feet further south, N. 37° E. < 75°; and this last dip continues thence far along the coast. If all the strata from the brook are on the south side of the fault, the succession in ascending order is as follows:

	Feet.	Inches.
1. Greenish argillaceous shale and sandstone	34	0
2. Brown argillaceous shale and sandstone	3	6
3. Greenish and grey sandstone	12	0
4. Measures concealed	125	0
5. Grey and dark-bluish argillaceous shale	30	2
6. Measures concealed. Probably dark shale	21	9
7. Dark bluish-grey argillaceous shale	18	6
8. Measures concealed. Probably dark shale	28	0
9. Brown and greenish argillaceous shale	3	8
10. Measures concealed. Dip S. 62° E. < 75°	179	0
11. Greenish and grey rusty sandstone, much broken	63	0
12. Measures concealed	77	0
13. Sandstone	6	0
14. Measures concealed	10	0
15. Grey sandstone in flaggy and thick beds, coarse in places; broken plants and upright trees. Thickness somewhat indefinite. The unlikeness to the beds of last section proves the fault indicated by the dip	148	0
Total thickness	759	7

The thick sandstone follows the shore for a great distance to the southward. It is just possible that this is the same as No. 11.

Overlying it at a vertical distance of about 200 feet, all of which seems to be sandstone of the same kind, the strike of the lower beds being from point to point on the shore, is another band of sandstone. The relation of this to the underlying measures is as follows:

SECTION NEAR BEAR ISLAND.

	Feet.	Inches.
1. Grey and greenish-grey rusty sandstone, passing in places into dirty grey concretionary limestone or calcareous sandstone. It contains prostrate trees (*Calamites*, etc.) and root beds. Some layers are fine and smooth, waving, with a reddish tinge, others coarse and rough. Toward the bottom it contains patches of grey, calcareous, concretionary, rusty conglomerate. Seen on the shore at intervals for more than a mile	200	0

2. Sandstone similar to No. 1	450	0
3. Black shale containing *Cordaites* and *Neuropteris* in abundance	4	0
4. Greenish-grey, crumbling, dirty argillaceous shale	15	0
5. Measures concealed	40	0
6. Greenish argillaceous shale, containing nodules of light-grey clay ironstone as large as cocoanuts, with streaks of hematite and traces of coaly matter	5	0
7. Grey rusty sandstone	9	0
8. Grey rusty sandstone with carbonized plants, shaly, flaggy, and thick-bedded, greatly contorted	47	6
9. Measures concealed	6	0
10. Reddish and greenish, friable, argillaceous shale	8	0
11. Grey, jointed and broken, rusty, friable and coherent sandstone, generally fine and in thick beds; carbonized plants	10	6
12. Bluish-grey, micaceous, areno-argillaceous shale or sandstone	11	6
13. Measures concealed	21	0
14. Light-grey and rusty thick-bedded sandstone	27	0
15. Measures concealed; perhaps reddish rocks	18	0
16. Greenish-grey sandstone, the lower half indistinctly seen	12	0
The dip is overturned to about S. 5° E. < 80°.		
Total thickness	884	6

Black shale. Plants.

Plants.

Bear Island.

The next rocks seen about half a mile further and near the west side of the cove north of Bear Island, have a very different dip N. 65° E. < 85°. If no fault intervened, therefore, No. 16 would be overlaid by about 600 feet of concealed measures, and among them the thick sandstone (1 and 2.) That this should remain unseen is improbable, and the next rocks are of a different character—softer and reddish. These are on the western side of Bear Point, and are in ascending sequence as follows:

	FEET.	INCHES.
1. Greenish-grey, argillaceous, micaceous, waving sandstone	..	..
2. Reddish-grey, argillaceous, waving sandstone	6	0
3. Measures concealed. Probably like the foregoing	70	0
4. Greenish-grey and reddish sandstone	20	0
5. Greenish, reddish and brownish, rippled, waving, micaceous sandstone and argillaceous shale in alternate layers. Dip N. 67° E. < 74°	432	0
6. Measures concealed	..	..
Total thickness	528	0

Similar rocks are seen to overlie the preceding at many points on the peninsula between the Strait of Canso and Seacoal Bay, the dip turning further to the south at a lower angle. The thickness thus

Flat Head. present to the easternmost point of Flat Head would be about (< 50°) 4045 feet, the distance across the strike being one mile.

Hawkesbury black shale. On the St. Peters road, about a mile and a quarter from the chapel at Hawkesbury, black shale containing *Naiadites* is in the road which follows it on the strike about half a mile as far as a road turning off on the left at a small brook. In this brook below the road, grey argillaceous sandstone dips S. 70° E. < 72°, whilst lower down the dip is N. 81° E. < 65°, and half a mile above the mines road N. 84° E. < 70°.

Mines road. From the crossing of this brook along the mines road to the next brook to the eastward, reddish, fine sandstones, with conglomerate in patches, form rocky barrens, and similar rocks continue as far as the right branch of Little River, where they are compact and coherent. Blocks of quartzose sandstone, grit and conglomerate appear on the track from the mines to McVicar's.

River Inhabitants. On the St. Peters road from McLeod's bridge to the Kemp road post-office, reddish and purplish, argillaceous, shaly sandstone is abundant, and prevails also on the roads to Inhabitants Basin and toward Black River, with light greenish and grey, coherent, fine sandstone.

Buchanan's. Near Buchanan's, grey and bluish-grey argillaceous shales occur. Fragments of coal are reported to have been picked up in a brook on the east side of the road to the basin, but its occurence here is very doubtful. Blocks of bright reddish and purplish sandstone and shale occur towards McRae's mill and the Grandique road. A descending section near the mill is as follows:

Section at McRae's mill.

	FEET.	INCHES.
1. Greenish-grey, more or less sandy, argillaceous shale........	20	0
2. Greenish and purplish, mottled, somewhat sandy argillaceous shale........	25	0
3. Greenish and grey, rusty, shaly and flaggy sandstone.......	40	0
4. Reddish argillaceous sandstone........	10	0
5. Grey, greenish-grey and purplish argillaceous shale.........	10	0
6. Reddish, crumbling, argillaceous sandstone........	15	0
7. Grey, greenish-grey, reddish and purplish argillaceous shale, sometimes sandy and containing broken plants. At a driblet near the top of the hill the dip is N. 60° W., nearly vertical........	120	0
8. Bluish and greenish argillaceous shale........	15	0
9. Reddish and purplish argillaceous shale; not well seen.....	30	0
10. Greenish-grey papery shale........	10	0
11. Reddish, crumbling, more or less sandy argillaceous rock....	15	0
12. Similar alternations badly exposed........	45	0
Total thickness........	355	0

West Bay. In the brook flowing along the Grandique road north of Neil McPhail's, these rocks are well exposed and also near the head of West Bay, where they are greatly contorted in some of the brooks.

Grey and reddish sandstone and argillaceous shale are seen in many of the brooks and roads between Bear Island and Hawkesbury, dipping as shown on the map. Bear Island to Hawkesbury.

Emery Brook is full of cascades and rapids. Below the small lake, the following rocks occur, the exposed thickness not being very great because they are cut on the strike: Emery Brook.

1. Reddish-grey, fine, flinty sandstone and argillaceous shale.
2. Dark-bluish, nearly black, micaceous, argillaceous shale, containing lenticular masses of limestone and sandstone, not slaty nor altered. Probably part of the section seen at the town of Hawkesbury. The interbedded sandstone is very coherent and not unlike that of Rocky Bay. Impressions of *Naiadites* quarter of an inch in length occur in some of the soft, argillaceous shales, and the limestones contain *Spirorbis*. Shells.
3. Grey, micaceous, often nearly compact, quartzo-felspathic sandstone, with bluish-grey argillite and bands of rusty-weathering, dark limestone, with obscure plant-markings.
4. Dark fine shales, interstratified with grey and blackish quartzites, with specks of iron pyrites. Between the layers of the shales are thin bands of calc-spar. The quartzites are as compact as any of those of Arichat. The shales on the contrary are soft, but sometimes coherent and contorted.
5. Grey ripple-marked quartzite and quartzo-felspathic sandstone appear at the head of tide-water in Emery pond.
6. Grey, ripple-marked quartzites overlie these rocks in the adjoining brook as far as the Crandall road.
7. Coarse and fine grey sandstone of the same brook east of the Crandall road. Crandall road.

In another branch of this brook which crosses the Crandall road further north, the dark shales are again well exposed with a two-inch band of rusty limestone, the dip being S. 68° E. $< 55°$. Up stream they are overlaid by grey, fine, coherent rocks forming cascades. Lower down are reefs of dark-bluish, finely laminated, argillaceous shale, patches of rusty limestone and grey crumbling shale, ripple-marked and containing globular concretions of more coherent argillite and bands of sparkling, rusty-weathering, compact sandstone and quartzite. Frequent outcrops of reddish-grey coherent strata, resembling those of Kemp Road and West Bay, form rapids and cascades in the Tannery Brook between Hawkesbury and Port Hastings, and on many of the roads toward the Big Brook road, barrens too stony for cultivation.

Extension of the Rocks of Plaster Cove.—The limestone, marl and gypsum of Plaster Cove are easily traceable back from the shore by pits, ponds and cliffs in the brooks flowing into the cove and on the Victoria and Big Brook roads. On the Victoria road the limestone has been quarried and burnt. It is bluish-grey, com-

pact or oolitic, banded or waved and full of veins of white, yellowish and pink crystalline calcspar, holding specks of iron pyrites. The joints contain soft, clayey matter, sometimes faintly tinged as if by oxide of iron or manganese. The resemblance to the Pirate Harbor or Blue Cape limestone is very striking, and there is every reason to suppose that they are identical. Associated with it are carboniferous marl and conglomerate, beneath which are the altered devonian rocks. Green marl is also seen in the Big Brook road near the second brook east of the fork of the Victoria road. Below the plaster ponds in one of the Plaster Cove brooks a grey, vesicular, rusty limestone, often dark and bituminous, containing rusty vugs of calcite, is accompanied by occasional outcrops of reddish-grey and greenish, soft, argillaceous marl, and followed by the plaster at the head of the pond.

Plaster Cove brooks.

In the most easterly of these brooks at the foot of the twenty-five feet fall, just above tidewater, are greenish-grey and reddish, micaceous sandstone and shale, quartz-veined across the bedding, very coherent and dipping steeply N. 70° E. Higher up are dark, coherent, argillaceous shales, succeeded by flaggy, fine, coherent sandstone or quartzite. Nearer the source of the brook, reddish-grey argillaceous sandstone occurs.

Limestone quarry.

In the branch flowing from the Victoria road at the limestone quarry, a greenish-grey, fine, coherent sandstone occurs just below the road, nearly vertical, with a southerly strike; followed by red and green soft clay rock. Further down is a cliff of bluish-grey, veined, compact limestone, like that of the quarry, followed by red and grey, mottled, micaceous, argillaceous shales and flags dipping S. 80° E. $<$ 85°, and overlaid by thirteen feet of dark, bluish-grey, rusty-weathering, bituminous limestone, with a few specks of iron pyrites. It has the aspect charcteristic of all the carboniferous limestones from Sydney to Gabarus, but which is wanting in those of St. Peters, Arichat, Guysborough and Hastings, perhaps owing to alteration. It is, moreover, full of encrinite stems and other obscure fossils, besides brachiopods, of all sizes, up to a third of an inch in length, which show on weathered surfaces the general form mineralized by crystalline calcspar. The limestone seems of fair quality throughout, and would probably make a good strong mortar-lime, although certain layers are rusty and sandy. A little further down it is associated with plaster.

Shells.

In a brook crossing the Victoria road further north, mottled, red and green, crumbling, argillaceous shale and sandstone are succeeded up stream by bluish and grey limestone, sometimes so pyritous as to weather bright yellow. The upper beds are impure, argillaceous or arenaceous. Fossils are not numerous although by no means absent.

Fossils.

It seems to be thicker than that described above and forms a succession of small falls.

In McQuarrie's fields, north of Dorton's bridge, is a light-colored, semi-crystalline limestone, probably overlying unconformably the conglomerate and quartzite of the vicinity and of Brown's mill. In the brook entering the north-west arm of River Inhabitants from the east, below the mill, it is whitish-grey and impure. It is variablo in dip as well as in color and texture, being hard, coherent, calcveined, shaly or even slaty, bluish-green, weathering into ridges and furrows, perhaps on account of the layers of argillite and sandstone which it contains. In general it may be said to resemble the limestone of Guysborough, St. Peters and the quarry at the Victoria road. Below it occur huge outcrops of coherent, grey conglomerate, the brook following for some distance the line of contact. Dorton's bridge Northwest arm

Limestone and plaster are first met with on ascending from the confluence of the north-west arm with River Inhabitants. The former is here light-grey, nearly compact, with white calcspar in veins, streaks and vugs, sometimes twisted and obscurely laminated, concretionary, and like that just described. The dip is south-easterly but obscure. A little higher up plaster occurs, as well as in the fields below the limestone on the right bank. Then a few blocks of friable conglomerate, probably carboniferous, occupy the brook, succeeded, higher up, by a conglomerate more like that of Arichat and by other very coherent rocks. A grey, jointed, coherent, rusty-weathering argillite follows; and higher up is a cliff of bluish and greenish-grey, micaceous, smooth, argillaceous rock, not always splitting into shales but having the lamination of the thicker layers distinct. It resembles the shales of Eddy Point and, like them, is generally unfossiliferous, although certain layers yield obscure specimens of *Leaia* and brachiopods, and some of them are also covered with small knots like rain-prints or fucoidal impressions and traversed by minute cracks, perhaps of recent origin. At one point the shales form the end of a small basin or plication. They have a jointed, slaty, ancient aspect, and are in all probability the rocks which overlie the gypsum at Plaster Cove. Up stream, bluish, light-grey and greenish, papery, micaceous shales are interbedded with coherent, compact, calcareous sandstone, and mottled red and green somewhat coherent argillite, covered in places by large, greenish, knotty, coherent concretions, full of iron pyrites. Certain drab beds are covered with broad ripple-marks. Dirty, greenish-grey, micaceous, flaggy argillite; jointed, coherent, light-grey, nearly compact, quartzo-felspathic sandstone; and reddish compact rock divided by joints into blocks the sides of which are sometimes nine inches in length, follow the Crandall road. Above Shells.

this road, mottled, grey, reddish and greenish argillaceous shales and sandstones in texture like the rocks of L'Ardoise, and continuous with those just described, form a cliffy, rocky brook and are well exposed as far as Dorton's bridge. Above the bridge bright-green, coherent shales and ripple-marked flags dip S. 5° E. $<$ 30° with considerable regularity for some distance. The shales are not seen in contact with the gypsum and limestone here, but near a small tributary from the left bank a bright-green marl perhaps indicates their proximity. The shales are more crumbly than those of Guysborough and have fewer quartz veins. In the immediate neighborhood, grey, coherent, Arichat conglomerate appears.

Rocks above McLeod's bridge on River Inhabitants.

In the large brook flowing into River Inhabitants from the eastward between McLeod's and the new bridge, reddish-grey argillaceous sandstone is first seen above the road, succeeded by indian-red, purplish, and mottled argillaceous and arenaceous, ripple-marked, contorted, jointed shale and sandstone, containing obscure plants and shells. Similar rocks are often met between River Inhabitants and West Bay. Interstratified with these in the next brook to the northward is a bluish-grey argillaceous shale and concretionary rock, sometimes an impure limestone, cross-jointed at irregular intervals parallel to the dip and strike. Good outcrops are seen in the lower part of this brook. Some of the sandstones are grey and very fine, with small carbonized markings; they have been quarried for rough work in building.

Long Stretch bridge.

In the large brook near the Long Stretch chapel, dark-grey, fine, micaceous, argillaceous shale and reddish and greenish sandstone, contorted and waving, dip in various directions, associated with a dark-grey, compact, bituminous, contorted limestone, containing minute crystals of calcspar. This is probably identical with the limestone seen in the fields near Mr. Archibald McDonald's house.

On the right bank of the river near the Long Stretch bridge, plaster pits are numerous, the country being as usual greatly broken, and the ground wet and clayey. Large hemlock and hardwood trees grow in the neighborhood of the pits. Above the road, light, reddish-grey argillaceous sandstone is occasionally seen, succeeded by flaggy argillaceous rock, bluish-grey and calcareous, or mottled, bright-red and green, coherent or crumbly, with layers of greenish impure limestone.

Lamey Brook limestone and gypsum.

Lamey Brook, below the Crandall road, exposes a bluish or light grey limestone about fifteen feet thick, in layers varying from three inches to two feet, strongly resembling that of Plaster Cove and full of encrinites and brachiopods. It contains dark films of free bitumen, is often earthy, rusty-weathering, vesicular, intersected by numerous veins of light pink and white calcspar a foot thick and downward, which also penetrate the underlying soft purplish and grey marls. Separated from

it by a concealed interval is grey gypsum with red concretionary streaks. Nodular masses of a dark, more or less crystalline limestone also appear, sometimes surrounded by a thin framework of gypsum; and a great part of the rock is spotted with the limestone which stands out on the weathered surfaces. The gypsum is associated with light-green gypseous marl. At the next turn in the brook below, the limestone again appears, containing patches of a concretionary conglomeritic variety. Below McMaster's sawmill a hard quartzose grit is interstratified with reddish and greenish shale and sandstone.

A carboniferous outlier occurs among the felsites in the south branch of McMaster Brook, consisting of red soft marl and highly bituminous limestone, apparently vertical with a south-west strike. On the road above, red and greenish marl are in contact with the syenite. McMaster Brook.

4th Syncline or Basin.—The North Princeville Brook in the falls and wild valley above River Inhabitants road displays fine exposures of red, purple, greenish and grey sandstone and shale, ripple-marked and micaceous. Higher up and in the neighboring roads and brooks these rocks are also seen. Princeville Brook.

The South Princeville Brook affords good outcrops at many points between the Big Brook road and River Inhabitants. Below this road, grey and dark-bluish, ripple-marked argillaceous shale, showing a considerable thickness with a low inclination, is mixed with flaggy, soft sandstone.

The rocks of River Inhabitants above the red bridge, and less than three quarters of a mile from the precambrian hills, are of great variety and interest and probably represent those which overlie the gypsum and limestone in Plaster Cove. They contain the "coal measures" of the source of River Inhabitants, and occur in ascending order as in the following section, which is, however, only approximate, most of the strata being measured in the bed of the river: Coal measures of the River Inhabitants syncline.

SECTION OF CARBONIFEROUS ROCKS IN THE BASIN BETWEEN GLENDALE AND BIG BROOK.

	Feet.	Inches.
1. Precambrian syenite and felsite of the hills	..	..
2. Measures concealed for nearly three quarters of a mile to the red bridge over River Inhabitants. On the strike are the Glendale limestone and conglomerate	3320	0
3. Measures concealed above the red bridge. Dip N. 89° E. < 60°	300	0
4. Greenish-grey coherent grit and fine conglomerate	50	0
5. Greenish-grey, argillaceous and arenaceous shaly and flaggy beds, with layers of fine, coherent, micaceous sandstone	265	0
6. Reddish-grey sandstone, sometimes almost flinty	0	0

	Feet.	Inches.
7. Grey, fine, quartzo-felspathic sandstone or quartzite, in thick beds, forming a cascade. Dip S. 85° E. < 70°........	15	0
8. Alternations of rocks similar to the foregoing..............	253	0
9. Reddish-grey, fine, argillaceous rock, not well laminated, associated with coherent sandstone, often calcareous and full of minute veins of calcspar....................	25	0
10. Frequent outcrops of reddish-grey coherent rocks, including a fine calcareous conglomerate. Dip N. 85° E. < 65°.	485	0
11. Grey, greenish and bluish, soft argillaceous shale and sandstone, with a nearly vertical dip.....................	330	0
Fossils at Glendale. 12. Dark-bluish shale and coherent grey marl with impressions of a minute bivalve shell and of *Leaia Leidyi*. Seen in small layers of limestone in the river just behind Glendale chapel..................................	10	0
13. Soft, red and grey argillaceous shale.....................	2	0
14. Reddish-grey, crumbling, argillo-arenaceous rock, like that of West Bay..	10	0
15. Bluish-grey argillaceous shale, with fine layers of calcareous sandstone, or impure limestone, somewhat contorted; followed by waved and contorted shales with polished, graphitic surfaces, sometimes as bright and smooth as glazed crockery. Seen only at intervals.............	390	0
Fossils. 16. Grey and greenish, evenly bedded, micaceous, argillaceous shales, containing fucoids and *Naiadites*. Dip S. 75° E. < 47°......................................	114	0
17. Measures concealed to the bridge on the road to John McInnes' house. Dip S. 80° E. < 40°..................	1500	0
18. Reddish and greenish-grey, shaly, fine, micaceous, argillaceous, soft, rippled sandstone, like that of West Bay. Dip S. 80° E. < 30°..............................	80	0
19. Reddish, crumbling, argillaceous shale, lenticularly bedded and enclosing bands of fine, coherent sandstone, sometimes rippled and waved. In cliffs and reefs. Dip S. 60° E. < 37°......................................	390	0
20. Reddish-grey, grey and greenish, fine, soft sandstone, in long reefs, breaking into large blocks which might be used for rough work in building. Several cascades, with a few concealed intervals. Dip S. 58° E. < 25°.........	648	0
21. Grey and reddish, fine, jointed sandstones, like those of St. Peters and River Bourgeois. Seen occasionally in rapids and falls................................	368	0
22. Measures concealed..................................	38	0
23. Sandstone and argillaceous shale; not well seen...........	75	0
24. Measures concealed. Two rusty springs about half-way....	315	0
25. Reddish and greenish argillaceous rocks...................	120	0
26. Measures concealed..................................	87	0
27. Reefs of reddish, greenish and grey fine sandstone..........	100	0
28. Measures concealed..................................	85	0

	Feet.	Inches.	
29. Argillaceous shale and sandstone in reefs..................	40	0	
30. A few exposures of rocks similar to the foregoing...........	26	0	
31. Measures concealed. Dip S. 48° E. < 18°. Occasional reefs not well exposed................................	500	0	
32. Bluish-grey, crumbling argillaceous rock, full of plant impressions and often a rich *Cythere* marl. Dip S. 43° E. < 10°....................................	27	0	Plants.
33. Black calcareo-bituminous wrinkled shale or limestone, in rhomboidal blocks of variable length and breadth, *Cythere*, *Spirorbis*, *Naiadites*.........................	0	9	Shells.
34. Dark, crumbling, argillaceous marl......................	0	6	
35. Bluish, compact, splintery, concretionary limestone.........	0	2	
36. Bluish, soft, argillaceous shale, with ironstone balls.........	15	0	
37. Indistinct outcrops of grey and greenish argillaceous rock, with thin bands of coherent quartzose sandstone......	63	0	
38. Rocks not well seen......................................	30	0	
39. Brick-red, earthy, argillaceous rock, traversed by green vein-like streaks......................................	25	0	
40. Underclay or crumbling bluish argillaceous shale, with two or three thin coaly layers. Shells...................	7	0	Coal seam of Upper River Inhabitants.
41. Black coaly shale, passing in places into coal..............	1	0	
42. Black soft shale..	1	3	
43. Coal..	1	8	
44. Dark argillaceous shale full of shells......................	4	0	
45. Dark shale, very coherent and calcareous, full of *Cythere*....	1	3	
46. Dark-bluish or blackish, well laminated argillaceous shale, crowded with *Cythere*, *Spirorbis*, *Naiadites*, and a few leaves and stems of *Cordaites*..........................	9	0	
47. The overlying shales are exposed in the bends of the river south of Neil McCuish's, being nearly or quite horizontal. It is probable that the rocks overlying the coal in this basin do not exceed 200 feet. The quantity of available coal in the basin, even if the seam were much larger, would be extremely small.........	200	0	
Total thickness..............................	10326	7	

Dark bluish and blackish shelly shales and sandstones occasionally appear as far as McIntosh's clearing, including a grey shale full of rootlets and ironstone balls. In one of the brooks in Neil McCuish's clearing is a thin band of bluish-grey pyritous limestone nearly horizontal or with a slight southerly inclination. Above the road to Big Brook, reddish and grey sandstone and shale are frequently exposed. Possibly other seams of coal may occur on this section. If so they can be found in the river or by boring, the strata being nearly horizontal and the surface not deep.

Overlying the banded felsitic rocks in McLennan Brook are indian-

red sandstone and grit, slightly micaceous, soft, fine-grained and seamed with calspar, associated with micaceous, reddish conglomerate, containing small pebbles of white vitreous quartzite, greenish felsite, crystalline limestone and mica schist. These rocks pass into one another. Falls occur, as is the case in all the brooks of the neighborhood, at the contact of the carboniferous and precambrian systems. Above these rocks comes a grey, thin-bedded limestone, about six feet thick, seamed with calcspar and containing obscure brachiopods. Just above the Victoria road is a dark-grey argillaceous shale. Below the road, dark and light grey and indian-red shale and sandstone with obscure *Naiadites;* and bright-red, greenish and grey, mottled, ripple-marked marls often occur.

Fossils.

In the next brook north of the mill similar strata are displayed, including beds of limestone-conglomerate. If this limestone be the same as that of Plaster Cove, a great change in the character of the rocks is indicated, those of McLennan Brook, especially the lowest, being much more friable than those of the red bridge not far distant. Such changes will, however, generally be noticed in tracing strata on the strike for a great distance.

Glendale.

In the brook at the Glendale post-office, soft, greenish-grey argillaceous shale, dark-grey calcareous shale containing *Naiadites* and fragments of plants, reddish and grey, micaceous, mottled sandstone, and arenaceous, laminated limestone, dip S. 57° E. $< 65°$. The limestone sometimes passes into grey shale. Higher up, purplish conglomerate and sandstone are underlaid by precambrian strata. In the brooks near Donald Smith's, a similar passage of a reddish argillaceous limestone into fine sandstone is seen. It thus seems to be variable and perhaps does not occur near the red bridge on the line of the section last given. Other brooks exhibiting these rocks need not be referred to, nor need the exposures on the O'Hanley and Big Brook roads be mentioned.

Irregular occurrence of the limestone.

River Denys.

The various branches of River Denys expose carboniferous rocks, none of which are altered like those further south, nor differ in any respect from rocks of the same age about the Bras d'Or Lake. Gypsum and limestone are of frequent occurrence, the latter being full of fossils including encrinites, corals and brachiopods. Many of the brooks, however, show no outcrops but flow through a wet or barren country in a slow winding course. Near the older rocks there is no obscurity on this account, but in the low land the dip is hard to discover. The Tannery Brook, at River Denys cross-roads, displays equally well the carboniferous rocks and precambrian mica schist and quartzites, from which they are largely made up. Immediately above the schists come reddish-grey, fine, friable sandstone, grit and conglomerate forming a

Gypsum and limestone.

Contact of carboniferous and precambrian rocks at River Denys cross-road.

gorge and fall; while further down stream an impure, bluish, greenish-grey and reddish, compact and splintery or oolitic limestone has been quarried.

Near Colin Chisholm's mill, in Diogenes Brook, is a dark bituminous limestone. Above the mill are blocks of sandstone, and beyond the first outcrop of crystalline limestone a light-grey, friable limestone-breccia, perhaps carboniferous, is mixed with conglomeritic limestone and underlaid by light-red, hematitic clay-rock, passing into pure hematite. **Diogenes Brook.**

On the Victoria road, between the cross-roads and Blue's mills, carboniferous strata are frequently in place, bounded on the west by hills of precambrian rock. Near Blue's mills are pits indicating plaster, and about Ashfield (or Sodom) limestone and plaster also occur. **Blue's mills.**

Big Brook and its feeders often afford good sections of the gypsiferous rocks, but along the North Mountain the conglomerate so abundant on the Craignish side of the basin is absent in many places, although by no means in all. **Big Brook.**

In Big Brook, just above the River Denys road, grey, black-spotted, semi-crystalline, friable gypsum is associated with reddish sandstone, dirty limestone and concretionary limestone-conglomerate. The sandstone predominates largely and is of the same character as that found in the coal measures of Inhabitants Basin and St. Peters. In one of the tributaries a false-bedded, light-grey shaly variety passes into argillaceous, slightly micaceous, ripple-marked rock, displaced and broken, and is succeeded by bluish argillite and red sandstone, forming falls.

In the stream near the Big Brook school, similar rocks are underlaid by syenite. Some distance up among the older rocks blocks of concretionary limestone and sandstone frequently show the unconformability of this series to the precambrian. Conglomerate is found in the feeder just above the road at a little log house, underlaid by the prevailing red hematitic syenite. Sandstone and impure, concretionary limestone abound in other brooks along this road. **Precambrian strata.**

Nearer Denys Basin, at McKenzie Creek and in Little Harbor mill-brook, these rocks are occasionally present. At Donald Nicholson's, on the left bank, is a curious valley with mounds and depressions, ending against a cliff of gypsum. About Malagawatchkt pits are frequently seen, even where the plaster is concealed. The road down McKenzie Brook passes through a deep glen, the ponds in which perhaps indicate plaster. But the syenite is never far away, and rises in hills to a height of 760 feet. Unconformably overlying the syenite, in the broken land near McGregor's, is a grey, highly bituminous limestone, associated with bright-red and green marl. On the lake shore to the southward a grey, earthy limestone similar to that just men- **Brook flowing under ground.**

tioned, is succeeded by a high cliff of limestone-breccia or conglomerate, with sandy patches and variable contorted dip. At the western end it resembles the limestone of Plaster Cove, and contains obscure fossils; here it comes against and contains pebbles of dark-greenish massive felsites, compact or fine-grained, often like the rocks of Long Island, and probably trappean. Further west these become still more brightly and variously colored, are mixed with bright-colored limestone, and show lines of bedding like the felsites of Cape Rhumore.

Limestone of doubtful age.

Islands of Denys Basin.

Some of the many islands of the Bras d'Or Lake, near Denys Basin, show limited areas of gypsum and allied rocks. Militia Island and Point might, judging by the soil, be underlaid by plaster; and on the island several blocks were found. Pellier and Malagawatchkt Points are composed of gravel; Grammo Point, of gravel on the cove side; but on the north, white, jointed, broken gypsum about six feet, exposed for 120 yards, dips about N. 30° E. $<$ 7°. It contains crystals of selenite. About half a mile from this exposure, and again on the north-west corner of Boom Island, are others of grey and rosy selenitic gypsum, horizontally bedded. Only blocks are seen on Indian, Round, Campbell, McLean, Lewis and Cranberry Islands. McLean Point is low on both sides, but on the south side shows a small deposit of plaster. On Guion Point, an island connected with the shore by sandbars, plaster cliffs twenty-two feet high occur. The dip is variable. Low shores of sand and gravel, swamp and spruce occupy the rest of the basin.

Islands of West Bay.

The islands near North Mountain exhibit pink soil and low banks or flats. Several of them are cultivated. On Green and George Islands are considerable exposures of plaster.

5th Sycline or Basin.—The age of the strata of Craignish, Judique and South-west Mabou, is still involved in uncertainty; the conglomerate and grit of some of the Long Pond and Judique Brooks bearing a stronger resemblance to those of Queensville than the River Denys series; but they may be briefly referred to in this connection.

Craignish.

Near Craignish, indian-red soft argillite and greenish calcareous shale, veined with calcspar, micaceous and jointed, breaking into small irregular pieces, are in contact with a greenish calcareous felsite. Between Craignish and Heffernan Pond, soft indian-red and greenish-grey argillaceous shale and sandstone appear, dipping generally at a high angle and sometimes steepest near the shore, which perhaps indicates a fault running along the coast. To the northward they are greatly contorted, but often horizontal, with broken plants.

Low Point.

On the Low Point shore, greenish, very coherent, brown-weathering, quartz-veined, micaceous sandstone passes into conglomerate containing pebbles of felsite, quartz-felsite and other rocks.

The coherent conglomerates in contact with the syenite and amy-

gdaloidal rocks of the Craignish brooks are perhaps carboniferous. The pebbles and matrix are chiefly of red syenite, purple porphyry and other felsites, the pebbles being often a foot in diameter. On a diorite in one place rests a soft, bright indian-red argillite, overlaid by bright-green grit and coarse conglomerate, containing pebbles of syenite and amygdaloid.

In Chisholm Brook at Long Point, below the shore road, indian-red micaceous sandstone occurs. Near the lower mill is a soft, rusty sandstone, followed by quartzose-conglomerate, quartzo-felspathic sandstone, associated with grey argillaceous shale. These rocks appear in various places. The north branch of Chisholm Brook, where it flows from the Craignish Hills, displays an indian-red somewhat friable grit, with pebbles of quartz and felsite, overlying syenite and diorite. Reddish argillite and quartzose conglomerate succeed, and lower down is a gorge of greenish-grey quartzose sandstone, like that of Pirate Harbor. In one of the branches of the brook lavender grit and indian-red argillite, comparatively hard and coherent, contain pebbles of quartz. In another branch a similar argillite is found with grey or reddish quartzose sandstone and grit, less altered. In the main stream a greenish-grey, jointed argillite, with crystals of iron pyrites, and bluish or greenish-grey, micaceous quartzose sandstone, dip N. 50° W. $<$ 18°. Other soft rocks succeed. **Long Point**

Near the source of one of the Judique brooks, south of Graham River, indian-red, fine, soft, thick-bedded, argillaceous sandstone occurs, with dark-grey diorite. Lower in the brook is a light-grey, spotted, felspathic grit containing small pebbles of quartzite, schist and felsite, and a dark-grey, fine-grained, jointed, broken diorite, veined with calcspar and holding iron pyrites. Altered grit is above, with red, micaceous, fine conglomerate and sandstone dipping vertically. Felspathic grit is also found near light-grey, soft, coherent felsitic or trappean rock, sometimes argillaceous, containing vesicles, rusty or filled with iron pyrites. Indian-red, soft, micaceous sandstone succeeds, with thick beds of argillaceous shale and more coherent felspathic sandstone. Micaceous sandstones, spotted red and green, and running into mottled marl, grit and conglomerate, sometimes calcareous, extend to the shore Perhaps the lower portion of this section is devonian. **Judique.** **Igneous rocks**

Near Donald McPherson's indian-red marl and conglomerate overlie the syenite and stretch towards the shore.

In the brook south of Graham River, ovelying the grits, conglomerates and sandstones which are associated with volcanic rocks, occur red and green marl, sandstone and conglomerate, with dark argillaceous shale, containing a few *Naiadites*. **Fossils.**

Graham River, not far above the shore road, passes over beds of light- **Graham River.**

Fossils. grey argillaceous shale and slightly bituminous, fossiliferous limestone containing encrinites and corals. Higher up is a fine sandstone, light-grey, indian-red and calcareous, jointed across the strike; succeeded by red, marly, thick-bedded sandstone, seamed with calcspar, and red, fine, calcareous conglomerate interbedded with light-grey argillaceous shale. Similar alternations occur as far as the bridge on the old Judique road, where the rocks become more altered and coherent. About half a mile below the bridge, on McMillan's farm on the left bank, is an exposure of thirty feet of light-grey, clear-grained sandstone, which has been quarried for local use. It shows very indistinct bedding and is jointed across, the joint-faces presenting themselves in the cliff. It stands the weather well, and in the blocks used in the foundations of houses at Judique there are no rust-spots.

Sandstone quarry.

Volcanic rocks of Graham River.

Just above the old Judique road, Graham River runs, in a deep valley, over fine coherent argillite and coarse, grey sandstone greatly altered by trap dykes, with large specks of silvery mica. Rough, altered grits and argillites are in contact with diorite at a small fall in the river and again in the branch from the bridge at Allan McDonald's, fine, bluish argillaceous shale, sandstone and coherent quartzose grit in which the quartz sometimes appears in crystals are cut by grey, massive, porphyritic trap.

The intrusive rocks of this neighborhood are of considerable interest. As already remarked, some of the amygdaloids and felsites of the General Line road, Horton Brook and McMillan Point may be of the same age. In certain cases they are clearly precambrian, in others the actual contact is concealed, and, as the extent to which the surrounding strata are altered may not be great, this is doubtful. But in Graham River there can be no doubt of the existence of a number of large dykes which cut not only the precambrian but also the overlying rocks. These vary greatly in color, composition and texture, but are essentially dark, massive, bluish and greenish, granular and compact, chloritic, epidotic and quartz-veined, dioritic and felsitic rocks, which lie above and among the grits and argillites of the brook. At one point of contact red rocks seem to dip into the diorite, without very perceptible alteration; but in general the metamorphism is so great and the blending of the two so complete that no line of separation can be drawn between them. At the fall mentioned above a greatly altered conglomeritic grit is in contact with dark diorite traversed by a vein of epidote; and in one of the small neighboring tributaries dark diorite and compact felsite occur.

Rory Chisholm's Brook.

In Rory Chisholm's Brook, near Rory Chisholm's, and everywhere in the vicinity grey, feebly coherent sandstone, grit and conglomerate, like those of the head of South-west Mabou River, occur in rough out-

crops, seldom continuous. Further down the brook are purplish and reddish fine argillaceous sandstone, like that of Lamey Brook, and reddish-grey conglomeritic grit, succeeded down stream by fine reddish and greenish-grey sandstone and argillaceous shale, often micaceous. Below the mill, near the River Denys road, the exposures are exceptionally good, consisting of reddish and purplish, coherent conglomeritic rocks. Further down is a bed of yellowish-grey, compact limestone, below which the brook flows among meadows and marshes.

In the brook at Judique chapel grey and red, fine argillite, sandstone, grit and conglomerate are well exposed. One of the conglomerate beds contains a vein of heavy spar, resembling in this respect the slates beneath the limestone at Plaster Cove. Near the school at Ben Noah, indian-red, argillaceous, micaceous sandstone and grit, composed of felspar and quartz, dip N. 72° W. $<$ 31°. The country is broken into irregular hills, meadows and valleys. Grey, coarse, quartzo-micaceous sandstone occurs in many places, as well as indian-red, crumbling argillite, grey sandstone and greenish-grey marl with small veins of pink gypsum.

Judique.

Ben Noah.

Green marl is seen in a little brook at Judique chapel, and near the stage stables, a light-grey limestone, twelve feet at least, is interbedded with calcareo-argillaceous shale and sandstone, in the vicinity of gypsum.

In Judique Intervale Brook, above the old stone house, outcrops of red and grey sandstone and bluish argillaceous shale, dip as shown on the map. Sometimes the reddish sandstone passes into a grey conglomerate containing pebbles of greyish grits and quartz. Fine grey sandstone and conglomerate, containing pebbles of quartz and syenite, occur higher up, with bluish and reddish argillite. In other branches of this brook the rocks are similar. Below the old stone house a greenish-grey, argillaceous shale, with fragments of plants, dips N. 82° W. $<$ 48°. In a small brook flowing into this, shale is also exposed. Lower down, the brook flows among intervale and ponds, with reddish soil.

In one of the branches of South-west Mabou River, from River Denys road, for a considerable distance down, only blocks of sandstone and syenite occur. Below the junction with a large brook from the right, blocks of grey, soft sandstone appear, followed, below the confluence of the main branch, by grey, coarse grit and conglomerate dipping N. $<$ 10°. Occasional outcrops of friable conglomerate and micaceous grit, grey and often coherent, extend to the bridge at McLeod Settlement. In the main river, below the Barren or River Inhabitants road, grey, coherent, jointed, conglomeritic grit, with serpentinous matter in the cleavage planes, and grey, soft, argillaceous, micaceous

South-west Mabou river.

sandstone, sometimes flaggy, extend to the confluence of the brook just described. In the branch which flows from the road between River Denys and Glencoe, near Squire McDonald's, coarse, reddish, friable sandstone, grit and conglomerate, and grey, rusty-weathering, quartzose sandstone have a northerly dip. On the road itself and in the branch of the river which occurs near Glencoe, grey, coherent sandstone, grit and conglomerate abound.

lque harbor The seashore north of Judique Harbor is interesting, because it displays the various exposures better than any part of the coast between this harbor and the Strait of Canso. The land slopes gently to the shore, with stunted, gnarled spruce and light-red soil. The following sections were measured between Judique and Port Hood:

SECTION OF STRATA ON THE SHORE NORTH OF JUDIQUE HARBOR, IN ASCENDING ORDER.

		Feet.	Inches.
	1. Reddish and greenish, mottled, waving sandstone, sometimes shaly toward the bottom	23	0
	2. Greenish and grey, crumbling, argillaceous shale	10	0
Plants.	3. Light-grey sandstone, containing concretionary limestone at the top and covered with broken plants. Ripple-marked. Occasional thin layers of dark shale	8	4
	4. Greenish, grey and reddish argillaceous shale	6	6
	5. Reddish and greenish, mottled, shaly, waving sandstone	2	4
	6. Measures concealed. Dip N. 72° W. < 50°	70	0
	7. Reddish-grey sandstone	4	0
	8. Grey, fine, rippled sandstone, waving, marked with plants; sometimes in large, smooth flags	5	6
	9. Alternations of grey argillaceous shale, and thin-bedded, fine, argillaceous sandstone	3	6
	10. Light-grey, flaggy, rippled sandstone, with thin layers of shale	3	4
	11. Reddish and brown micaceous shales, with bands of reddish and greenish mottled sandstone. A few bands of bluish-grey argillaceous shale, with broken plants. In the brown beds occur fine, coherent nodules	138	0
	12. Reddish and light-grey, fine, micaceous, argillaceous sandstone sometimes in thick beds, but usually shaly, rippled and crumbly	18	0
	13. Light bluish-grey, argillaceous shale, with thin layers of sandstone and a reddish band	7	6
	14. Reddish and brown, crumbling, argillaceous shale, with reddish and greenish rippled sandstone, sometimes marked with broken plants or seaweeds. Irregularly or lenticularly bedded. Coherent, calcareous layers. Greenish and bluish shales predominate toward the top	180	0
	15. Light-grey, cream-colored and reddish calcareous sandstone in one or two thick irregular layers, not very coherent	11	0

	Feet.	Inches.	
16. Reddish and greenish, bluish and grey, shaly, crumbling, argillaceous shale and sandstone in thin alternate layers..	10	0	
17. Greenish and bluish crumbling argillaceous shale..........	8	0	
18. Reddish and greenish, soft, crumbling shale, with layers of micaceous, rippled sandstone. The shales greatly predominate. The top of this is at a point.............	456	0	Plants.
19. Rusty or dirty cream-colored, crumbling sandstone full of broken plants and trunks of trees, pyritized, carbonized and converted into a black, crystalline, silicious, oolitic rock. Many perfect crystals of selenite occur in the cavities and joints of the sandstone, which is in places broken into small blocks, whilst other parts are shaly. Pyrites and hematite are also present. The top layers are red and greenish, jointed and shaly...............	54	0	
20. Red and brown shales with greenish and bluish layers and sandstone bands..................................	58	0	
21. Rusty, light-grey, shaly, thick-bedded and flaggy sandstone, often little more than loosely coherent sand, full of broken plants and containing patches of concretionary limestone....................................	17	0	
22. Reddish and brownish shales as before, with a considerable thickness of bluish and greenish argillaceous shale toward the base. Certain layers of sandstone, show rain-marks, seaweeds and broken plants..................	204	0	
23. Measures concealed. Dip N. 87° W. < 45°. In part, if not all red, rocks..................................	67	0	
24. Reddish waving sandstone..................................	1	0	
25. Reddish and brownish shale with lenticular bands of reddish and greenish sandstone, more or less nodular, with more persistent, waving, shaly bands.....................	110	0	
26. Measures concealed. Dip N. 87° W. < 40°................	32	0	
27. Waving sandstone..	0	10	
28. Measures concealed..	38	0	
29. Greenish-grey, light-grey and reddish, shaly, false-bedded sandstone, full of broken plants, with occasional layers of argillaceous shale...............................	36	0	
30. Measures concealed in part, only a few reefs of reddish sandstone being seen. Probably all red sandstone and shale..	87	0	
31. Greenish-grey and light bluish-grey fine sandstone with rusty spots and markings of plants. Passes into red sandstone at top, with green spots..........................	33	0	
32. Measures concealed in a cove in which two fish-houses are at a small brook. Dip N. 79° W. < 40°................	170	0	
33. Greenish-grey, waving, sandstone in reefs..................	10	0	
34. Measures concealed..	80	0	
35. Reddish shale and sandstone............................	16	0	

	Feet.	Inches.
36. Measures concealed	679	0
37. Obscure outcrops of red rocks	233	0
38. Greenish-grey shaly sandstone, passing into shale; rusty spots; false bedding	30	0
39. Measures concealed	12	0
40. Grey, crumbling sandstone, with rusty plant-marks	6	0
41. Greenish and grey argillaceous shale with bands of light-grey flaggy and jointed sandstone, passing into shaly sandstone at top	50	0
42. Measures for the most part concealed, but consisting where seen of reddish argillaceous shale and sandstone. Dip S. 88° W. < 88°	82	0
43. Red shale and sandstone	10	0
44. Light-grey, fine sandstone in thick beds. Rusty markings of plants. Forms a point as far as an abrupt turn of the shore to eastward to a pond. Thickness doubtful at least	34	0
Total thickness	3114	10

Section of Strata on the South side of Little Judique Harbor, in ascending order.

		Feet.	Inches.
Gypseous rocks	1. White gypsum full of crystals of selenite	38	0
	2. Gypseous marl	45	0
	3. Whitish gypsum with fibrous veins and selenite crystals	9	0
	4. Gypseous marl, chiefly reddish, but also greenish and grey	140	0
	5. Grey, calcareous, coherent sandstone, marked with plants	40	0
	6. Greenish, reddish and grey marl	50	0
Limestone.	7. Dark-grey, bituminous limestone, weathering light-grey	0	8
Coal.	8. Soft, argillaceous underclay, with obscure coaly matter, succeeded by argillaceous shale and sandstone	45	0
	9. Thick grey sandstone of the usual character, with an irregular conglomerate at the base and at intervals above. Irregular, light-grey, concretionary masses	79	0
	10. Greenish, argillaceous shale with ironstone nodules, including, toward the top, dark, argillaceous shale, lenticularly bedded with sandstone	30	0
	11. Sandstone. (No. 48, p. 110 F)	120	0
	Total thickness	596	8

This sandstone skirts the shore to Cape Susan, where the underlying measures are again displayed in ascending order:

		Feet.	Inches.
Gypseous rocks	1. Whitish, reddish and greenishselenitic gypsum	6	6
	2. Greenish and grey impure limestone and calcareous sandstone. Local and of varying thickness 9 in. to 1 ft.	0	10
	3. Greenish and reddish argillaceous shale, crossed by gypsum veins	1	0

		FEET.	INCHES.	
4.	Greenish, reddish and whitish gypsum, here and there mixed with green and red marl	5	0	
5.	Gypseous marl in irregular bedding, of variable color and texture, traversed by plates and veins of gypsum	10	0	
6.	Whitish gypsum without much admixture of marl	9	0	
7.	Greenish-grey and reddish, compact, impure limestone	5	6	
8.	Reddish or brownish marl with greenish streaks	45	0	
9.	Grey, rusty-weathering, bituminous limestone, full of shells and encrinites, somewhat mixed with marl	12	0	Fossils in limestone.
10.	Red or brownish marl with greenish streaks	36	0	
11.	Dark-bluish, bituminous limestone passing into calcareous, compact sandstone	7	0	
12.	Brown marl with green streaks	11	6	
13.	Dark, nodular, bituminous limestone. Lenticular	1	6	
14.	Reddish and grey marl	4	6	
15.	Limestone	1	0	Limestone.
16.	Reddish and greenish marl, with one or two nodular layers of rusty limestone. Not well seen	25	0	
17.	Nodular limestone of varying degrees of purity	8	0	
18.	Reddish and greenish marl like 16	40	0	
19.	Rusty, very calcareous marl with masses of vesicular limestone	5	0	
20.	Light-grey and rusty sandstone, becoming conglomeritic and mixed with bluish argillaceous shale at bottom. Ironstone and calcareous nodules. Traces of coal	5	0	
21.	Bluish and greenish argillaceous shale mixed with sandstone	4	0	
22.	Grey, thick-bedded, crumbling, calcareous sandstone. The section of these last beds is very variable In places red shale extends to the sandstone, masses of rusty limestone being also present. At one spot a dark argillaceous shale is mixed with red shale, immediately above which comes the sandstone. Again the sandstone seems to come up to the rusty marl. The thickness of the sandstone is doubtful owing to its obscure bedding. It must be remembered, however, that the whole section is only approximate	80	0	
23.	Red and green marl with limestone masses	18	0	
24.	Rusty, crumbling sandstone	10	0	
25.	Grey, argillaceous shale or underclay with large *stigmaria*, dark streaks and ironstone nodules	7	0	
26.	Calcareous coaly streak	0	1	Coal.
27.	Greenish-grey, rusty, argillaceous shale, with nodules of dark pyritous limestone	0	9	
28.	Clay with coal streaks	0	9	Black shale.
29.	Wrinkled calcareo-bituminous shale full of *Cythere*, *Modiola* and *Spirorbis*	2	3	
30.	Grey and greenish argillaceous shale, with sandstone layers and nodules	5	0	

			FEET.	INCHES.
Coal.	31.	Underclay	1	3
	32.	Coaly shale and coal with wrinkled calcareo-argillaceous shale, the last being on top	1	7
	33.	Grey and greenish argillaceous shale	4	0
	34.	Rusty, crumbling sandstone	10	6
	35.	Greenish, argillaceous shale, nodular and arenaceous toward the bottom, but coaly and argillaceous with *stigmaria* and calcspar veins at top. Full of long needles of gypsum ¾ inch and downwards	13	9
	36.	Grey sandstone like 22	43	0
	37.	Greenish, bluish and grey argillaceous shale with ironstone nodules and layers	50	0
	38.	Underclay	6	0
Coal.	39.	Coal, very pyritous, with much mineral charcoal and a little coaly shale	1	10
	40.	Rusty, fine, coherent sandstone	3	0
	41.	Shaly, crumbling sandstone	2	0
	42.	Dark-blue argillaceous shale	2	9
	43.	Black coaly shale	0	4
	44.	Greenish argillaceous shale passing into arenaceous shale and sandstone	4	0
	45.	Light-grey, shaly, rippled, crumbling sandstone	2	0
	46.	Reddish-black wrinkled shale with limestone layers *Naiadites*	1	6
	47.	Bluish and greenish fine argillaceous shale	7	6
	48.	The thick sandstone of Kate and Susan Points (No. 11, p. 108 F)	..	..
		Total thickness	522	2

Continuation of the above section, southward, from No. 1, p. 108 F:

			FEET.	INCHES.
	1.	Whitish, reddish and greenish selenitic gypsum	6	6
Gypseous rocks	2.	Reddish marl with waving lenticular layers of greenish and reddish impure limestone and beds composed of nodules	27	0
	3.	Conglomeritic rock, apparently nearly all concretionary, of various colors, weathering whitish-grey. The nodules vary in size from cocoanuts downward. It forms a reef dipping S. 65° E	2	0
	4.	Reddish marl, sandstone, etc., in confused bedding	160	0
	5.	Light-grey flaggy sandstone	3	0
	6.	Shales as before	16	0
	7.	Grey sandstone passing into grit at bottom	27	0
	8.	Bluish-grey argillaceous shale	5	6
	9.	Sandstone, passing into arenaceous and argillaceous shale	4	6
	10.	Shaly, false-bedded sandstone	40	0
	11.	Greenish and reddish argillaceous shale, not well seen	40	0
	12.	Reddish sandstone, argillaceous shale and calcareous grit	21	0
	13.	Greenish and grey rusty sandstone, passing upward into reddish, shaly, rippled waving sandstone	180	0
	14.	Reddish and greenish rocks, seen only on the reefs with calcareous bands	..	..
		Total thickness	532	6

Millstone Grit.

It has been remarked that part of the series described in the carboniferous sections may represent the rocks referred to the millstone grit and coal measures in the Sydney coalfield. Perhaps the higher rocks of the basin, to the eastward of Inhabitants River, should be separated from the strata containing the coal, as suggested by Mr. Gilpin, and Dr. J. W. Dawson has suggested that the fossils of Scott Brook near St. Peters indicate the possibility of the occourrence there of rocks of his upper coal formation. There are certainly signs of overlapping and perhaps unconformability about McDonald's Mountain, but this may be complicated to the northward by a fault which gives rise to the vertical dip at McRae's mill. Further surveys will doubtless give increased value to the description of the structure of the Richmond coalfield which is at present confessedly incomplete. It is to be regretted that the records of the explorations made in search of coal, which might have been of great assistance, have nearly all been lost. **Subdivisions of the carboniferous series.**

Surface Geology.

Incidental mention has been frequently made in the course of this report, of the more striking surface features of the region to which it refers. The post-tertiary deposits are vastly inferior in interest and importance to those which have just been described, consisting merely of beds of clay, sand and gravel, enclosing larger rounded and angular blocks, derived either from the rocks *in situ* immediately beneath, or from the neighboring hills. And the transported material seems to constitute only a trifling proportion of the loose detritus that covers the consolidated strata to a greater or less depth, by far the greater part being formed from their ruins. For this reason it is generally easy to affirm from an examination of the soil, the nature of the underlying rock, whether this is a limestone, sandstone, shale, conglomerate, felsite, syenite or what not. This is no doubt owing to the hilly character of the country, and it follows that few of the brooks, however slow-flowing, fail to indicate at intervals the nature of the stony floor. Great dependence can, therefore, be placed on the geological structure as interpreted from a careful mapping of the various outcrops, even where it is as complicated as in the Richmond coalfield. Nor are these superficial deposits usually of great thickness. In many parts of the region the rock crops on the surface and forms large tracts even in the low lands too rocky for cultivation and known as "barrens." Examples occur over the greater part of Madame **Barrens.**

Island, on the mainland of Nova Scotia, between St. Peters, Inhabitants Basin and Hawkesbury, in part of the country along the Big Brook and Victoria roads, in the various hill ranges and behind Port Hood and Judique. Among these rocky barrens, however, occur others which might be reclaimed by judicious draining and admixture of other soils, and which will be again alluded to.

Lakes. Lakes are numerous in the southern part of this field, but are seldom of great depth, and have commonly rocky outlets. Those between the St. Peters road and the shore of Inhabitants Basin are very shallow, covered half-way across with reeds, and surrounded by marsh with large numbers of pitcher plants, hops, roses, lilies and alders. From Summers' Lake two outlets flow independently, one to Tracadie, the other to Little Tracadie. From Grant Lake there is but one brook which, a short distance below the lake, divides into the Auld Cove and Mulgrave Brooks. Ned's Lake is a shallow rush and lily pond, a great resort for ducks. Some of the lakes are very pretty, with hard clear bottom, banks clothed with spruce, intermingled with maple, beech and other trees, and full of trout. Along the shores of some of the smaller ponds in the neighborhood of Loch Cailean is a strip of marsh land with mosses, pitcher plants, white, bushy small bell-flower plants, alders, spruce and tamarac. A great part of the district between this and L'Ardoise is wet, barren spruceland, interrupted by rocky patches covered with purplish sandstone and quartzite, and intersected in every direction by winter woodroads. Near the foot of Cranberry Lake a fine rippled white and cream-colored sand occurs; but usually the lakes of this chain have rocky shores, low woody banks and echelon-jutting headlands.

Sand.

Brooks. Sluggish brooks flow in the barrens, widening into lakes and black ponds. These are most abundant in Richmond and Guysborough counties. The Black Brook of River Inhabitants flows in a flat country among alders, opening out at intervals into little ponds infested in the month of June with horse and black-flies, and forming in places an almost impenetrable alder-tangle, or when larger trees, such as hemlock, are present, they add to the misery of a Cape Breton "blow-down." Where exposed to the sun the reddish soil of its banks bakes hard white. This is a fair example of other brooks of the neighborhood such as Little River in part, Emery and Seacoal Brooks. Some of the mountain streams about Glendale and River Denys are difficult to ascend owing to the large blocks of rock that encumber their beds. Others are surrounded by marshes bordered by bramble bushes, ivy plants and hops, five or six feet long and interlacing among the trees of the blow-down. It is sometimes a slight recompense for the toilsome traverse of a blow-down to be able to pick the raspberries, blackberries,

"Blown-down."

black and red currants from the bushes before pushing through them. Although the August gale of 1873 raged with less intensity in Inverness than in Cape Breton county, and although the lapse of time has broken down many of the branches of the fallen trees some of the brooks about Glendale and Queensville still give evidence of its power, and if any person wishes to see a sample of its destructive work, let him ascend for a short distance the first brook to the southward of McLennan's mills, on the Victoria road. Slimy pits, bogs, grass and moss-marshes, willows and alders, little ponds and creeks abound between the low banks of some of the sluggish and tortuous brooks about the basins of Inhabitants and Denys. Intervales and marshes occur on the lower reaches of most of the Judique brooks, the banks of which are also low. The Guysborough brooks flow alternately in mossy marshes, pools and creeks, and in rocky rapids, gorges and cascades. Falls of great beauty often occur among the mountain brooks, whose banks are sometimes finely mossed with reddish, yellowish, grey, pink and white mosses. In the lower part of the larger rivers, fed from the mountains and subject to periodical freshets, it might be expected that changes would frequently take place in the direction of the various windings; and that such is the case is shown by the deposits of sand, gravel and entangled trees which have been accumulated in old channels, within the memory of the inhabitants. On River Denys a large tree was seen buried under four feet of sand and gravel, with a thick sod on top. In Black River, West Bay, a large landslide a few years ago changed the course of the river, hurling down trees, soil and stones to fill up the old channel. At Ross Creek another landslide was observed on the shore.

Falls.

Change in the rivers.

Landslidess.

Many of the mountain brooks rise from springs, and even in the lowland springs also occur. Most of the water of the small lake near McRae's mill, Black River, comes from one of these, under a bank. Those of the east or scarped side of North Mountain are numerous, strong and beautiful, generally clear and cold in summer, never freezing in winter. On the north side of Rabbit Island is a strong salt, sulphur spring issuing from the ground opposite a driblet that feeds a pond, and depositing sulphur on the eel-grass of the pond. On Landrie Lake is a spring from which flows water tasting strongly of iron, and depositing a yellow crust plentifully on the ground in the vicinity. Near McMaster's mill, Queensville, is a salt spring the water of which has been analysed by Mr. Hoffmann (page 7 H.) In the limestone formation many brooks rise from springs, and one at River Denys, after running underground for a considerable distance, emerges again a large brook. A spring, strongly ferruginous and salt issues from the side of a slope in

Springs.

Mineral spring.

a marsh near John McNeil's, at River Tillard, covering the ground with iron ochre.

Marshes. Salt marshes of considerable extent occur, along many of the shores, as at McLeod and Ross Creeks, on West Bay, at St. Peters Inlet, Inhabitants and Denys Basins, Judique and elsewhere, the ground near the water being often shaky. Shaking marshes also occur on some of the lakes. Near one of the branches of Princeville Brook is a trembling moss and grass marsh, and similar land is more frequent in the neighbourhood than rock. Wet mossy spruceland of a somewhat similar character is seen in a branch of the millbrook near McLeod's bridge.

In the north-west arm of River Inhabitants layers of peat or impure brown coal occur at the bottom of a high clay bank, and led to the supposition that coal might be found there.

Ice grooves. Glacial striæ were observed at the following localities:

1. A short distance south of Eddy Point, broad and deep .... S. 77° E.
2. Clam Harbor Lake .... S. 12° E.
3. Petite Anse .... S. 67° E.
4. Mackerel Cove .... S. 75° E.
5. Arichat Head, in regular grooves and polished, rounded mounds, the sides of which are also grooved .... S. 40° E. and S. 20° E.
6. Morrison Harbor, West Bay .... S. 56° E.
   This is the direction of the greater number of the striæ, but some larger and deeper grooves run S. 79° E., and other lines are present.
7. North shore of Janvrin Island .... S. 65° W. < 45°
   They run along the rounded face of a sandstone abutting on the shore. Some of the grooves run nearly horizontally and are deep and apparently newer; others even dip the other way, but this is the prevailing direction.
8. On the Grandique road, east of Buchanan Lake .... S. 78° E.

TIMBER, CLIMATE, ETC.

Most of this district has suffered from forest fires, which have destroyed the timber and given rise to barrens or a second growth. Timber was in former years largely exported from Cape Breton, and, Saw mills. although it is now scarce, the number of small saw and shingle mills on the brooks is remarkable. They are used principally to supply the local demand, and none of them are extensive. White and red spruce, Trees. small pine, tamarac, white birch, alder, poplar, black ash, willow, oak, maple, moosewood, beech, mountain ash, dogwood and elm are

the principal trees. Ironwood is found on the Craignish and North Mountains.

Marsh plants are abundant, especially on wet barrens, and among others a beautiful *Cypripedium*, in which the upper three divisions of the flower are snow-white, a small one springing from the centre is white at the stalk, yellow at the tip; the boat-shaped petal is pink, with a double lip. But perhaps the most marked feature in the flora of the district is the number and variety of its ferns, which occur in all the barrens, marshes and woods, in the crevices of the rocky walls of the gorges and the creeky stretches of the brooks, and in great profusion in the glades whence the brooks have their origin. The following species are enumerated by the Rev. E. H. Ball as occurring in the district under examination *:—*Polypodium vulgare*, *Pteris aquilina*, *Asplenium trichomanes*, *A. thelypteroides*, *A. filix-fœmina*, *Phegopteris polypodioides*, *P. dryopteris*, *Aspidium thelypteris*, *A. noveboracense*, *A. fragrans* (only one habitat, Hartley's waterfall, Pirate Harbor, Strait of Canso), *A. spinulosum*, *A. intermedium*, *A. dilatatum*, *A. recurvatum*, *A. cristatum*, *A. filix-mas* (found at Whycocomagh), *A. aculeatum* (Marble Mountain, Mabou, Mulgrave), *A. marginale*, *A. acrostichoides*, *A. lonchitis*, *Cystopteris bulbifera*, *C. fragilis*, *Struthiopteris Germanica*, *Onoclea sensibilis*, *Woodsia Ilvensis* (Whycocomagh), *Dicksonia punctilobula*, *Osmunda regalis*, *O. spectabilis*, *O. Claytoniana*, *O. cinnamomea*, *Botrychium Virginicum*, *B. lunarioides*, *B. simplex*.

Marsh plants.

Ferns.

The animals are the same as those mentioned in last report. Bears and wildcats are occasionally trapped in the North and Craignish Mountains. Foxes infest the intervales of Rivers Denys and Inhabitants. Many of the lakes are full of trout. Clams frequent the mud, and loons, ducks and geese occur on the surface. Gaspereaux and salmon ascend some of the streams. Salmon are found in River Tom as far as the lake from which it comes. Trout and eels are the only fish of Loch Lomond. In many of the lakes and brooks the fish are netted, dams being constructed to prevent the passage of any except into the net. In the L'Ardoise brooks nets can be counted by the half dozen. Oysters occur in large numbers at Malagawatchkt.

Animals.

Fishing is the pursuit of the greater number of the inhabitants, but good farms occur along the rivers, especially in the intervales of the Inhabitants and Denys. The soil of these intervales or meadowlands is usually pinkish reddish-brown and clayey, and when not cultivated they are overgrown with alder and spruce. They produce excellent hay, although sometimes devastated by floods. The varieties of soil are interesting: the clays are white and dark-bluish, with fragments of

Occupation of the people.

* Transactions of the Nova Scotian Institute of Natural Science for 1875, p. 149.

plants. Soils of a white color are characteristic of coal measures and similar strata. Purplish tints overlie the rocks of some parts of Madame Island, Guysborough and the Strait of Canso; whereas the plaster and limestone districts are reddish or pink. A section of the soil in the bank of River Inhabitants at one point showed:

	FEET.	INCHES.
Loam	4	0
Bluish clay	1	6
Vegetable mould, including leaves, twigs, stems, roots of trees	1	6

Sometimes, however, the banks are of sand and gravel.

There are areas of land about River Denys underlaid by beds of clay which might be drained and rendered productive. These are wet and mossy, sometimes with rusty clay soil. Some of the shallow lakes could doubtless be drained. Mr. Millidge, C.E., has already surveyed Shoal Lake for this purpose, and a scheme is on foot to drain Lake Ainslie, the largest body of fresh water in Cape Breton.

The farms of North Mountain and Malagawatchkt are good, but being on the slope of a steep hill their cultivation is difficult. The situation on the sunny side of the hill, and their being underlaid by calcareous strata, make up for many drawbacks. Still, few of the farms are worked in such a way as to yield a full living for the occupants, who consequently go to sea, fish or seek work elsewhere.

Farm products

The season is said to be a month earlier on the western coast, than on the Atlantic seaboard and sowing often commences in April. Severe gales frequently visit the coast before or soon after the crops are gathered. One of these occurred on the 29th of April, 1879, and another a month later. Wheat is grown in Inverness county, but not much in Richmond. The rust and weavil spoil it. Squire McDonald, of Hay Cove, planted two bushels in 1878, which yielded about ten. Oats, barley, hay and potatoes are the chief products. One bushel of potatoes sometimes yields fifteen.

Scenery.

The scenery of some parts of the district is unsurpassed in Cape Breton, and extensive views may be had from the tops of some of the hills. On a hill not far from Glendale, in an old clearing, is one of these. In the foreground are the ruins of the hut of a former inhabitant of the place, a lover of nature rather than of comparative ease and an intervale farm, or perhaps compelled by necessity to seek the hills. The bright-green color and rounded tops of the birches and beeches present a strong contrast with the dark-green conical form of the spruces. The valley of a small brook, rapidly deepening and carving the hills on either side from where they meet in a tapering

point, opens to view in the distance a wedge-shaped tract of country, flooded with the light and shade of the flying fog-wreaths, and diversified by the clearings and woodlands scattered over its surface. The broad valley of River Inhabitants, stretching seaward, is clearly traceable by the clearings along its intervale and its sloping banks. Chedabucto Bay extends as a silver band, widening toward the east, and backed by mist-enshrouded Canso and a heavy bank of fog. On the left and looking northward, are the blue ridges of Craignish and the headwaters of the Rivers Inhabitants and Denys. Near the clearing is a splendid large spring, the source of all the water in the neighboring brook, and a resort of cattle.

The country opposite Guysborough is also beautiful, groves of hardwood, hedges and fine residences bordering the salt water, with its picturesque islands.

Economic Minerals.

Coal.—It has been already stated that coal occurs in several localities throughout this region in strata associated with marine limestone and gypsum. Further study is required to complete the mapping of the faults and folds that traverse these measures, but it appears probable, as already mentioned, that all the known outcrops of coal and carbonaceous shale are about the same horizon and more or less lenticular. Perhaps this is also the case with the coal of Little Judique, Port Hood and the north, although the underlying strata are different on the western side of the Craignish Hills. **Coal more or less irregular.**

In the black *Naiadites* shale of Scott Brook, near St. Peters, coal was looked for in vain. A slope was driven on the seam in the bank of the brook, but soon abandoned. The resemblance of the associated strata to the true coal measures is remarkable. At St. Peters, just below Cameron's shop, on the shore a seam of fireclay was followed into the bank by digging, on the supposition that coal would be found. Pits were also sunk near Cameron's on the post road; but no details concerning them could be obtained, and it is doubtful whether the bedrock was reached. Other explorations were made about Anse au Loup, but without result. **Scott Brook.** **St. Peters.**

Coal has been largely wrought near Inhabitants Basin at Coal Brook, Caribacou and Little River, but the quantity and quality of the coal have disappointed the sanguine expectations of the explorers. As work had been suspended for many years at the time of our visit, the information here presented is derived largely from Brown's Coalfields of Cape Breton, the Reports of the Commissioners of Mines, and from private letters of Mr. Alexander McBean of the Vale Colliery, Pictou. **Sources of information.**

The mining work was done principally between the years 1863 and 1868. Since then a good deal of exploration has been carried on by McBean and others, but no systematic mining.

Coal Brook.

At Coal Brook fine grey, greenish and reddish sandstone and shale, containing plants, appear associated with several beds of coal. These have been explored by pits and borings, but the thickness of the seam was not seen by us.

At the most northerly of these pits coal was obtained about ten feet from the surface. Thirty-five yards north of this a boring was made eighty-four feet deep, which struck no coal. Coal is indistinctly seen, with an underclay, in the bed of the brook just below. Only four inches was visible, although the seam is said to be three feet four inches in thickness. A tunnel was driven about seventy-five feet on the seam, and some twenty tons of coal taken out. The roof is crumbling, argillaceous rock, without fine lamination. At another slope further down the brook a seam of three feet mixed coal and shale is said to have been discovered. The shale contains *Cythere*, *Cordaites*, fish teeth, etc. The coal detritus on the bank is not good. Ferruginous water comes from the level. Lower down is another level, driven to meet a shaft which was twenty feet deep and from which eighty tons of coal are said to have been extracted. On the shore a short distance to the eastward of the mouth of the brook a borehole is said to have cut about eight inches of dirty coal. Upwards of $5,000 were spent in exploring at Coal Brook and the neighborhood where, according to McBean, there are a three-feet seam, a four-feet seam and several small seams from six to eighteen inches. In two pits sunk by McBean on the east side of the brook, the coal was poor and irregular on account of an upthrow fault on the east side between the pits. The coal was very good on the west side. The eight-feet seam should crop in the pond to the south of and near the mouth of Coal Brook, and drift coal occurs on the surface at the south side of the pond. If the coal runs regularly with the strata it should be found by boring near the gypsum on Evans or Freeman Island. Between 1863 and 1878, about 8125 tons of coal were shipped from the Richmond mines at Little River; and about $53,000 spent in building a tramway and sinking shafts.

Fault.

Coal on Evans and Freeman Islands.

A lease was taken out by Mr. Marmaud, who subsequently transferred his interest to an American company. An engine of thirty horse-power was erected for pumping and drawing.

McBean's section of the strata at this mine is as follows:

Section of coal measures at Little River.

	FEET.	INCHES.
Coal	3	0
Strata	154	0
Coal	4	0
Strata	60	0
Coal 2-4 feet	3	0
Strata	45	0
Coal 2-8 feet	5	0
Total thickness	274	0

Remarks by Prof. Dawson on the character of Little River coal.

Separated from the four-feet seam by five feet of shale, another, ten inches thick, is said to occur by Dr. J. W. Dawson. Of these he says (Acadian Geology, p. 397): "The coal of the principal bed is hard, and very little injured by exposure. Its fractue is uneven and crystalline, with glistening surfaces; and its texture is very uniform, the lamination or reed being rather indistinct, and almost free from dull coal or mineial charcoal. Its specific gravity is 1·38. When burned in a stove or grate, it ignites readily, fuses, swells and cakes, giving a strong flame and a lasting fire. It leaves a rather large quantity of brownish ash. In a smith's forge it works well, its behaviour being similar to that of Pictou coal. On analysis it is found to contain:

Volatile matter	30·25
Fixed carbon	56·40
Ash	13·35
	100·00

"Compared with the coals of Pictou and Sydney, the Little River coal is more bituminous than either, or contains more volatile matter and less fixed carbon. It contains about the same quantity of earthy matter with Pictou coal; but in quality and color the ash resembles that of Sydney. Practically it will be found to be a serviceable coal for domestic fires, well adapted for smith's use, and, from the large quantity and high illuminating power of its gaseous matter, probably a good gas coal. There should be little waste in its extraction, and it will suffer little by being banked or kept in the open air. It contains more sulphur than the Pictou coal.

"The coal of the small bed (No. 2) is somewhat similar to that of No. 1, but it is more impure, and contains much bisulphuret of iron."

Mining operations.

The two upper seams of McBean's section, which are nearly vertical at the mine, have been opened in several places by slopes and shafts.

*The first shaft was sunk to the depth of fifty feet in the three-feet seam. East from it another shaft was sunk forty feet between the seams. and connected with the first by drifts. From this depth the four-feet seam was worked to the west 250 feet and to the east 750 feet. This shaft was then sunk an additional forty feet, and a drift was put into the four-feet seam. Slopes were afterwards driven to the west of the shafts, 120 feet in the three-feet seam, and in the four-feet seam 150 feet. To the east of the eighty-feet shaft another one was sunk on the three-feet seam also eighty feet; and further east one 130 feet. The first eighty feet shaft was continued in 1866 to a depth of 200 feet, and outof it at that depth a tunnel or stone drift was driven to cut the seam at a distance of 162 feet. On each side of this drift levels were driven.

A modification of the long wall system was adopted in working these seams. The coal was taken by rail to a shipping wharf, distant about 2¾ miles. The surface erections consisted of an agent's house and a block containing thirteen tenements. Few of these are now standing.

McBean's explorations.

McBean tried to trace the Little River coal to the north-west of the mine, and found the surface over sixty feet deep. By running the course of the coal about half or three-quarters of a mile to the north-west, the limestone and plaster cross the strike of the coal at the mine. He also ran the course of the seams toward River Inhabitants, crossing the measures for over half a mile with pits and tunnels, close enough to prove every foot of the beds, but found no coal. He does not think he went far enough to the dip.

Mr. Brown's opinion of the prospects of these mines.

Of this field Mr. Brown remarks: "†Any attempts to ascertain the true position, extent and consequent value of the seams will be attended with much expense, as the country is low and there are few cliffs or natural sections. . . . . The outcrops of the strata also are concealed by a thick deposit of boulder clay. The seams all occur in situations favorable for shipment, but it is not likely that, unless they can be found in less highly inclined positions, they can be worked to any great depth, as in addition to the difficulty of working vertical seams, the expense of keeping the mines free from water will be a very serious obstacle and greatly increase the cost of production." If, however, the seams extend in workable form beneath Freeman and other islands, as indicated before, one of these difficulties would be to some extent overcome, as the strata are there less inclined and more accessible. Moreover, the railway lately finished to connect the Intercolonial with the Strait of Canso will render these seams of much greater value.

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* Reports of Commissioner of Mines, 1863-1868.

† Coalfields of Cape Breton, p. 42.

The coal measures of Glendale, River Inhabitants are described with the rest of the section at page 97–98. Glendale coal measures.

Pieces of coal are reported to occur in the bank of Queensville Brook below McMaster's mill; but the existence of coal in this vicinity is doubtful.

In the brook that flows into Seacoal Bay near the mine, not far above the bridge, grey rocks have a nearly vertical dip. Coal detritus occurs at a pit near the road, and also a little further up stream, also surrounding many old pits and associated with black calcareo-bituminous shale and limestone, very coaly, with cone-in-cone concretions, veined with calcspar containing fish remains, obscure plants and shells, such as *Cythere* and *Naiadites*. Above the coalpits fine grey sandstone has a north-west vertical strike, and higher up, at a fall, there is a north-easterly steep dip. High up the brook black coaly shale occurs in a pit, said to be twenty-two feet deep. On the hill beyond, huge masses of grey and whitish coarse quartzose grit occur with a southerly dip; and between this and the Strait of Canso or sea shore, only blocks of grey sandstone and nearly vertical outcrops occur. Coal mines of Caribacou.

Only 716 tons of coal were shipped from Seacoal Bay from 1863 to 1865, although no less than $13,000 were spent in exploration and mining.

Principal Dawson* states that the coal of Seacoal Bay is a seam of mixed coal and bituminous shale, eleven feet eight inches in thickness. Mr. Campbell† mentions the occurrence of eight workable seams ranging, in thickness from three to eleven feet, and several beds of smaller size, whilst in a subsequent report it is stated that several seams occur, varying in size from three to seven feet, only one of which four feet thick was mixed. This was entered near the shore by an adit driven across the measures 350 feet till it cut the seam at a depth of twenty feet below the crop. Contradictory statements concerning the coal seams. Mining operations.

An analysis given by Principal Dawson of the best coal, selected from the thick bed, shews:

Volatile matter	25·2
Fixed carbon	44·7
Ash	30·1
	100·0

Iron Ore.—Hematite occurs in the joints of some of the felsites about West Bay as druses or films. It is distributed in minute veins in the syenite of Big Brook and River Denys. At Mackerel Cove, Madame

* Acadian Geology, p. 395.

† Report of Commissioners of Mines for 1863, p. 20.

Island, a small seam of hematite, varying in thickness from a mere line to an inch, runs through the bank for about ten feet. At Ragged Head, Guysborough County, the devonian conglomerates contain numerous blotches and films of specular iron ore, of no economic value, and west of Stewart Pond blocks of specular iron ore, sometimes a foot thick, mixed with quartz, have been picked up in the fields and on the beach. The quartzose sandstones of the shore contain scales and scaly crystals of hematite and green carbonate of copper in the joints, and blackened impressions of comminuted plants in the bedding planes, while the hematite occurs also in small strings in quartz veins. At one place the ore assumes the form of an irregular gash vein from which pieces six inches thick may be obtained, but to the eastward it runs into ordinary films. Several small deposits are in the neighborhood.

Hematite in Guysborough county.

Ironstone of Scott Brook.

Ironstone is found with limestone in nodules and thin layers in the sandstones and shales of Scott Brook, near St. Peters. Magnetic ore is present in the sand of Rocky Bay, just north of Shaw Brook. The iron ore of Whycocomagh has already been frequently referred to. Other deposits are said to occur in the neighborhood.

Big Pond Iron ore.

A visit was made to a pit opened by Burchell and Morrison, in search of iron ore in the tributary of Breac Brook, East Bay, about three-quarters of a mile above Rory McLeod's mill. Much money has here been spent in vain, for the openings have been made in a crumbling carboniferous conglomerate formed from the underlying felsitic rocks of the neighborhood, in which all the iron found is present as a film on the surface of the pebbles, which on weathering gives the characteristic bright red streak of red hematite. A great quantity of ore had been extracted, but from the pile not one solid piece of hematite as large as a hen's egg could be obtained.

Iron ore was again sought for by Ingraham and others near the 21-mile post on the St. Peters road, but no discovery of importance made.

Gillis and Matheson mine

The Gillis and Matheson location was worked during the summer of 1878, and ten or fifteen hundred dollars spent in sinking shafts and extracting ore; but the operations do not seem to have been successful; for although in the pile taken out there is a large proportion of excellent ore, yet this does not form more than one-third of the whole, the remainder being conglomerate, like that of Burchell's pit. The pits had fallen in, so that it was impossible to examine the face of the mine; but we were informed that all the accessible ore had been extracted and that none had been obtained from the deepest shaft. Everything tends to prove that the ore is a deposit at the contact of the carboniferous and precambrian formations, like those seen near McDougall Point and elsewhere; and in mining these deposits this cir-

cumstance should be kept in mind and the ore followed along the line of contact.

Galena.—A considerable quantity of this ore of lead was discovered many years ago in the limestone at the head of Arichat Harbor, and to some extent wrought.

Copper Ore.—Traces of green carbonate of copper were observed in a quartz-felsite in a brook just west of the Morrison road near West Bay, associated with greenish, soft, soapy, calcareous rocks, like those of the Coxheath and Gabarus copper mines. Minute traces were also observed in some of the carboniferous rocks. Copper pyrites is reported to occur at North-east Mabou and also at Skye Mountain; but these deposits were not visited. Some work has been done at the copper mine of the Gillis Lake road (Report for 1877-8, p. 29 F.) by Mr. Burchell; but although the ore has been found in many places, it cannot be said to have improved. Apparently the deposit is like those of Gabarus and the French road. A good deal of yellow and purple copper pyrites, with traces of red hematite, is scattered through a large mass of compact and brecciated felsitic rock, the latter are very calcareous and full of a soft, soapy, talcose mineral. The strike seems to be about N. 40° E., the dip variable. One of the beds has yielded rich specimens; and to test its quality beyond the brook, a tunnel six feet high and four to six feet wide has been driven from the water level about twenty feet (1878), cutting layers containing minute traces of ore; but the bed in which the best indications were seen has not yet been reached. The tunnel costs six dollars a foot advance and passes through a dark, hard, compact felsite, in which are one or two softer bands. At the mouth of the tunnel are several feet of the soft, soapy, calcareous breccia, and at the end, very calcareous strata are met with. Ore has also been obtained much higher in the brook, from other beds; but as far as can be judged there is no regularity in its distribution. Copper ore is also said to have been found in some of the brooks near the Coxheath road at Battleman's, above the mineral spring.

Burchell's Copper mine.

Gold.—At Cape Porcupine and in Clam Harbour River, above the Middletown road, gold is said to have been discovered some years ago in the devonian slates, and some quartz was sent away to be tested. Nothing is known of the result owing to the conflict of testimony, but it was probably unsatisfactory. No traces could be detected in the veins, which are small and irregular.

The quartzite associated with the mica schists at Glendale and River Denys cross-roads, were also believed to be auriferous, and a good deal of money was spent in testing them. A stamp mill was erected to crush the quartz at the latter place, but has been allowed to fall to pieces.

Limestone.—The most valuable deposits of this rock are indicated on the map. Several of these have been largely quarried and may be briefly enumerated.

Arichat.

Behind the Arichat chapel is a small limestone quarry in a dark-grey, very compact stone, veined with calcspar and containing encrinite stems.

Pirate Harbor.

At Pirate Harbor a limestone, probably hydraulic, has been somewhat largely quarried, both for burning and building. It is of doubtful though considerable thickness, light bluish-grey, shaly or thick-bedded, often minutely banded or waved, brecciated, cut by veins or streaks of calcspar. About a mile north of Pirate Harbor this limestone is again worked at McNeil's quarry, where it is at least fifteen feet thick, highly bituminous, non-fossiliferous, rather earthy, but some beds are more crystalline and probably better. It has been exported, but it is said to be inferior to that of Lennox ferry. Traces of fluorspar were detected. Specimens from this quarry have been examined by Mr. Hoffmann.

Lennox ferry limestone quarries.

A limestone which has always commanded a ready sale on account of its excellent quality, has been quarried for upwards of twenty years at Lennox ferry. It is for the most part sent to Prince Edward Island, burnt there and used as a fertilizer. The quarries are owned by Messrs. Clough, Fraser and Shannon. Mr. Shannon states that about 500 tons were shipped last year from his quarry; and that in all 2000 tons have been taken from it since first opened. The selling price at the wharf is eighty cents a ton; at Prince Edward Island it sells for two dollars a ton, the freight costing about sixty cents. It is bought by shipload by agents who burn and retail it to farmers by the barrel. There is also a kiln at the ferry to burn lime for local consumption. From Clough's quarry about 1500 tons per annum are exported, and about 1000 from Fraser's.

Lennox ferry.

Gypsum.—There is a large bed of excellent plaster at Lennox ferry, from which a large quantity has been shipped, although nothing has been done with it for several years. Before 1873 about 1500 tons are said to have been exported yearly; since then only a few cargoes. The August gale of 1873 having destroyed the wharf and buildings, they were not replaced. Another cause for the cessation is, Mr. Clough says, to be found in the decay of Arichat shipping. Formerly a numerous fleet of small coasting vessels, owned in Arichat, after lying all winter, loaded with plaster which they sold at an advance sufficient to pay the expenses of their voyage to American ports to seek freight. This fleet is now nearly extinct, and Arichat depends for its existence on fishing and its position as the county-town. The plaster is of two kinds, and as the quarry extended, the best looking alone would be taken by the shippers, who bought it at their own risk and knew

that an inferior article would not sell in the United States. At length it became somewhat expensive to extract and the market was occupied by other quarries more favorably situated.

The gypsum of Plaster Cove, Little River and other localities, has been sufficiently described in the course of this report. None has been shipped lately. Plaster Cove.

Clay.—There is a great variety of clays in the valley of River Inhabitants and elsewhere, some of them, doubtless, fit for making bricks. At L'Anse au Loup, near St. Peters, clay is seen at low water. In the vicinity on Brick Point, there is said to be a good deposit from which the French made bricks. St. Peters.

Fireclay (altered felsite), like that of Coxheath (Report 1875-76, p. 423), occurs in the Sporting Mountain (page 7, F.)

Sand.—On the shore at Campbell Point, Malagawatchkt, is a deposit of fine sand suitable for building purposes, of which 2000 barrels have been used in St. Peters canal. Malagawatchkt

Building Stone.—No large and good deposit of building stone is known among all the sandstones of the region, which are usually too highly tilted and broken to be available. At several places, however, stone has been found to serve local purposes; the best of which is perhaps found in Graham River, near Judique, and described at page 104 F. Some of the sandstones of Inhabitants River and West Bay break into large blocks which are used for rough work in building. Graham River.

Heavy Spar.—In the Judique chapel brook, near John Cameron's a deposit of heavy spar or baryte, in veins in a fine conglomerate, has been opened by Mr. Brown of Port Hastings. No great quantity was found, however. Baryte also occurs in traces in the devonian strata near McMillan Point, on the Strait of Canso. Judique.

Graphite or Plumbago was found by Mr. R. G. Fraser of Halifax, at Glendale, where a considerable quantity of impure graphite, or rather graphitic shale, is seen in large lumps around the mouth of a pit said, to have been twenty feet deep, sunk near the contact of the syenite and overlying sandstones and shales. A specimen analysed by Mr. Hoffmann was found to contain about fourteen per cent. of graphite. (Report for 1879-80, page 2, H.) Glendale.

Marble.—Reference has been made in previous reports to the quarry at Marble Mountain. No work has been done to develop the quarry. Other exposures of crystalline limestone, none of which, however, are so favorably situated, have been mentioned in the description of the George River limestone. Marble Mountain.

Syenite, granite, and other varieties of ornamental stone, might be obtained from some of the hill ranges, but none of them have yet been used.

GEOLOGICAL SURVEY OF CANADA.
ALFRED R. C. SELWYN, LL.D., F.R.S., F.G.S., DIRECTOR.

REPORT

OF A

GEOLOGICAL EXPLORATION

OF THE

MAGDALEN ISLANDS,

BY

MR. JAMES RICHARDSON.

1880-81.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

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1881

MONTREAL, 1st May, 1881.

ALFRED R. C. SELWYN, ESQ., F. R. S.,

Director of the Geological Survey of Canada,

Montreal.

SIR,—I have the honor to submit, herewith, my report of the Geological exploration which you directed me to make of the Magdalen Islands during the summer of 1880.

I have the honor to be,

Sir,

Your obedient servant,

JAMES RICHARDSON.

REPORT

OF A

GEOLOGICAL EXPLORATION

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MAGDALEN ISLANDS,

BY

MR. JAMES RICHARDSON.

1880–81.

I left Montreal on the 9th of June, for Pictou, in Nova Scotia, where a few days were occupied in inspecting the coal deposits in that neighborhood. On the 23rd of June I embarked in the weekly mail steamer,* and arrived that day at Amherst Island, the largest and most southerly of the Magdalen group, situated in the Gulf of St. Lawrence, between 47° 12′ and 47° 51′ north latitude, and 61° 10′ and 62° 16′ west longitude. The group consists of thirteen small islands, bearing the following designations:—

Magdalen Islands.

Amherst,	Coffin,
Entry,	Old Harry Head,
Deadman,	Grosse,
Grindstone,	North-east Cape,
Alright,	North Cape,
Shag,	Bryon.
Wolf,	

And about fifteen miles beyond Bryon to the north-east are the celebrated Bird Rocks.

With the exception of Deadman and Shag, which are only bare, rocky islets, North Cape is the smallest of the group, having a superficial area of from 80 to 100 acres.

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* This steamer leaves Pictou every Friday morning, and reaches Amherst Island in about twelve hours.

Relative position and size of the Islands. All these so-called islands, except Entry, Deadman, Alright, Shag and Bryon, are connected with each other by long, narrow sand-banks or dunes. Between Amherst and Entry, lying to the east, is a passage of about five miles in width of open water. Deadman lies nearly eight miles west of Amherst, while Bryon lies thirteen miles north of North Cape. Amherst Island extends from east to west about nine miles, and from north to south, at the widest part, about three miles.

About ten or twelve miles north of Amherst are Grindstone on the west and Alright on the east, separated by a narrow channel of 300 or 400 feet in width. From the east and west ends, respectively, of Amherst, narrow sand-banks extend north to Grindstone, the space between them being occupied by a stretch of shallow water from three to four miles wide, which, though called Basque Harbor, is really a salt lake or lagoon, without any permanent opening to the sea. **Basque Harbor.**

From Hospital Cape, on the north side of Grindstone Island, a narrow sand-bank runs about eleven miles north-east to Wolf Island, whence it continues about eleven miles further in the same direction to North Cape. Immediately south of North Cape lies Grosse Island. From Grosse Island the sand-banks extend easterly for about seven miles to East Point, then westerly and south-westerly by North-east Cape, East Island and Old Harry Head to Coffin Island, and form in this distance the irregular shore line of the great lagoon, or Grand Entry Harbor. **Grand Entry Harbor.** This harbor, with a depth of from one to three fathoms, is accessible from the Gulf by a passage at the west end of Coffin Island, three fathoms deep and less than a quarter of a mile wide. Between Grosse Island, on the north, and Coffin Island, on the south, the harbor is about three miles wide, with a length of about thirteen miles from Wolf Island to North-east Cape.

South-west from Wolf Island Grand Entry Harbor becomes a shallow sheet of water, scarcely navigable for small boats for five or six miles, where it again deepens and widens to form House Harbor, the entrance to which is by the narrow passage already mentioned as separating Alright and Grindstone Islands. Neither the passage nor the harbor exceed three fathoms in depth.

Effect of storms. During exceptionally heavy storms openings are sometimes made through the sand-bars, but they are soon filled in again by the drifting sand, under the influence of winds and waves. Some time before the date of my visit an opening of this nature had been formed immediately north of Hospital Cape, and gave temporary access to House Harbor from the west. No trace of this passage now remains. The sand-banks, though not often used as lines of communication between the islands, can be travelled without much difficulty, either on foot or with wheeled vehicles.

In the examination of the islands no measurements were made; the Admiralty chart, from a survey made in 1833, by Lieutenant P. E. Collins, was used, and notwithstanding that the outlines of the shores had to a certain extent changed, through the destruction of the soft rocks in some places and the increase of sand in others, no difficulty was found in locating and recording with sufficient accuracy the observations made on the various rock exposures, which generally occur only in the coast cliffs and on the shores.

On the north side of Amherst Island, facing Pleasant Bay, the following section, in descending order, is exposed. The highest beds seen are at Butte du Portage, the dip being W. 30°, N. < 31°:—

Section on Amherst Island.

	Feet.	Inches.
Grey, soft crumbling sandstone, in beds of from one inch to ten inches thick	21	00
Measures concealed	40	00
Sandstones, as before, with numerous thin seams of calcareous spar and specks of specular iron ore throughout	54	00
Grey sandstones, interstratified with red sandstone...	69	00
Reddish-colored sandstone, a hard, compact bed, with ripple marks	6	00
Reddish and grey-colored hard sandstone	13	00
Reddish, hard, massive bed	4	00
Grey sandstones, with some soft, green beds, holding fragments of sandstone	5	00
Soft, grayish shales	1	00
Grayish green beds, with strings of white gypsum	13	00
Soft, green and grey arenaceous beds	1	6
Greyish green arenaceous beds, very porous and crumbling; ripple marked throughout in various directions indicating cross-bedding—estimated...	120	00
Greyish and reddish sandstone, thin bedded, and apparently regular, but soft and crumbling	64	00
Do., do., do	52	00
Grey green and red sandstones, ripple marked	38	00
Grey sanstones, variegated with red	45	00
Do. do., red and green sandstones	21	00

[This is to the second point west of Demoiselle Hill. The dip here changes to S. 40°, W. < 34°.]

	Feet.	Inches.
Grey, red and greenish, soft, crumbling sandstones	24	00
Red bed, with specks of green and grey, soft argillaceous matter, and fragments of red jaspery rock, from 2 to	4	00
Red, soft sandstones, one layer shows false bedding...	9	6
Red shale, with grey, soft blotches	0	9
Red sandstones	1	8

Red, crumbling shale	0	6
Soft, green shale, from 6 to	0	10
Red sandstone, with blotches of green sandstone	15	00
Red sandstone, where seen	86	00
Measures concealed	150	00
Total thickness	856	9

The rock masses underlying the above section are of very considerable, though unknown thickness, and consist of an agglomeration of sand, clay, gypsum, and doleritic rocks. The softer parts seen in the sea cliffs bear a marked resemblance to an ordinary superficial accumulation of reddish clay, and sand of the drift period, with the exception that the whole is traversed with a network of fine, fibrous gypsum, in seams varying from a quarter of an inch to four or six inches in thickness. Occasionally harder portions are met with, consisting of a greenish diabase, or dolerite, through which the net-like fibrous gypsum also penetrates; in some instances the diabase forms the largest part of the mass.

This rock is very full of joints, which are often found to be lined with white calcite, and occasionally with closely arranged, small and beautifully-formed crystals of specular iron ore. Sometimes the rock is amygdaloidal, but the joints are so numerous and so close together that an ordinary hand specimen can rarely be obtained. Pyrolusite (peroxide of manganese) and hematite are more or less disseminated throughout these rocks, and as, in some instances, they probably occur in sufficient quantity to be of economic value, I shall refer to them more fully in the sequel.

Manganese and iron ore.

Gypsum.

The most important useful mineral associated with this portion of the formation is probably gypsum. It occurs in deposits sometimes of very considerable dimensions, and appears to be enclosed within or in immediate proximity to the irruptive rocks. These gypseous deposits are well exposed along the sea shore, and where they run inland their course is distinctly marked, as is usual with such deposits everywhere, by funnel-shaped depressions, varying in depth from ten to sixty feet, and in extent from a quarter of an acre to perhaps three acres. In some of these the gypsum may be observed exposed in the bottom of the hollows, while in others there are small, round ponds, but generally they are dry and covered with a vigorous growth of grasses. The gypsum varies in color from almost a pure white to yellow and reddish, and appears to be of good quality. A few small exposures of black carbonaceous gypsum were met with; this variety, so far as observed, contains a small proportion of carbonate of lime. These gypsums and agglomerate rocks extend nearly east and west along the north coast of Amherst Island, disappearing to the east under the waters of

Amherst harbor and the open sea beyond. On the west, they crop out on the coast at the extreme west point of the island, and occupy it southward and eastward as far as South-west Cape, a projecting headland, composed of the overlying red sandstones. Beyond this point to near South Cape, the underlying rocks reappear on the shore, and like the lower portion on the north side, are interlaced with a network of fibrous gypsum. The rock at South Cape, and for a short distance before reaching it, consists of the overlying red sandstone, dipping south, the underlying gypsum and agglomerate rocks disappearing inland. On the coast from South Cape to Cap Percé, and beyond, red and sometimes grey sandstones prevail, with a southerly dip.

The harder portions of the lower rocks consist principally of diabases, sometimes forming conically-shaped hills of considerable elevation. One of these, called Demoiselle Hill, close to the shore on the south side of Pleasant Bay, rises to the height of 280 feet; while several others, situated more inland and to the north of South and South-west Capes, are even higher, the loftiest being about 550 feet. Along and around the flanks of these hills the funnel-shaped depressions already described occur very frequently, but at irregular intervals. It is evident that these agglomerate and gypseous rocks are of very considerable thickness, but from the continual occurrence of false bedding in the overlying sandstones, and the absence of any recognizable stratification in the rocks themselves, no positive data are afforded for calculation; however, they may safely be estimated as at least 2,000 feet in thickness. The structure and distribution of these rocks show that they are brought to the surface on an anticlinal axis, running approximately east and west, the detailed section already given along the north side of Amherst Island showing the strata dipping northward, while those on the south side are inclined in the opposite direction. Diabase of Demoiselle Hill Anticlinial axis

Entry Island is composed of similar rocks, and in the same order of succession, as those of Amherst, namely, a red and grey sandstone formation, with gypseous and agglomerate rocks beneath. Two of the conical-shaped hills on Entry Island rise to a height of 580 feet.

Proceeding north from Amherst to Grindstone and Alright Islands, the same geological features are repeated, the direction of the anticlinal axis, which on Amherst Island is due east and west, in the more northerly islands is E. 10° N., W. 10° S.

At Cap aux Meules, on Grindstone Island, the sandstones are well exposed in a perpendicular cliff, about 200 feet high, facing the sea. They here dip south $>31°$, and are for the most part grey, but occasionally green. Following the coast to the southward, very uniform and even-bedded red sandstones overlie the grey beds of Cap aux Meules, and extend to Red Cape, the south-east point of the island. They are Cap aux Meules

again exposed on Gull Island, off the south-western extremity of Grindstone Island, and they also form the whole of the cliffs, from twenty to one hundred feet high, along the west coast from Etang du Nord to Hospital Cape.

Etang du Nord and Hospital Cape.

On one of the highest of these cliffs, about a mile north of Etang du Nord, a lighthouse and fog-horn have been erected.

The action of the waves on these perpendicular cliffs wears the rock into very irregular and fantastic shapes. Sometimes caves are excavated large enough to admit the entrance, in calm weather, of a moderate-sized boat, while great portions are cut out with such regularity as to present a rude resemblance to the teeth of a gigantic comb.

From North-east Point southward to within a mile and a-half of the narrow channel that separates Grindstone from Alright, soft, crumbling sandstone is the only rock seen. Passing over to Alright, the red sandstones occupy the shore for the most part on the north, forming the south-east side of House Harbor. These sandstones are the only rocks visible on the east coast round to Cape Alright. The extreme east point was not examined, and may belong to the lower gypseous formation. Butte Ronde, a cliff facing the sea, is composed of grey, mixed with some red sandstones, dipping southward. Immediately to the west of this cliff the underlying gypseous and dioritic rocks occupy the south shore to near "the Narrows," extending also to the south shore of Grindstone Island, where they are seen within one hundred paces of Cap aux Meules, which, as already mentioned, is composed of grey sandstones, probably corresponding with the sandstones of Butte Ronde.

Butte Ronde.

It is unnecessary to describe the gypseous and doleritic rocks of the lower formation on these two islands, as they are precisely similar to those on Amherst. Except at the points indicated above where they appear on the sea shore, they are altogether in the interior of both islands. Their greatest breadth does not exceed one mile, and their westerly trend brings their line of junction with the overlying red rocks, about three-quarters of a mile to the north of the lighthouse on the west side of Grindstone Island. Their outcrop is seen about a mile east of the lighthouse, where the harder portions are indicated by several conical-shaped hills, the highest being 550 feet. Towards the east end of Alright Island two similar hills rise to a height of 420 feet. The funnel-shaped depressions, indicating the gypseous rocks, are also here met with along the base of some of the hills. The gypsum is occasionally seen in the bottom of the depressions, and where the line of these strikes the coast, masses of it jut out in the cliffs, or on the shore. Such exposures are to be seen on Grindstone Island, between Cap aux Meules and the east end of the island, and on Alright

Funnel-shaped depressions.

Island, on the south-west side, to the west of Butte Ronde. These characteristic features are very strikingly developed in passing along the travelled road leading from the Post-Office, on the east side of Cap aux Meules, northward to the opposite shore, a distance of about one mile, comprising about the total breadth here of the gypseous and doleritic rocks. These form a ridge rising from either side to a height of 200 to 650 feet.

On either side of this ridge the depressions at once attract the eye, especially on the north side, where they are somewhat elongated in the direction of the strike E. 10° N., and W. 10 S., and are arranged approximately in three or four parallel lines, looking like huge plough ridges, the top of each ridge being from thirty to fifty feet above the adjacent furrow.

Fossils in bituminous limestone.

Between Cap aux Meules and the east end of Grindstone Island, a bed of black, bituminous limestone was found interstratified with these rocks, from four to six inches in thickness, and containing fossils, these being the only fossils discovered during the season. The specimens collected have been submitted to Principal Dawson, with the view of ascertaining whether they afforded any clue to the geological age of the formation.

Principal Dawson says:—"I should think the fossils herewith returned indicate, so far as they go, a lower carboniferous age. The most characteristic is a small specimen of Bakervellia antiqua, a very widely distributed species, of which I send one of my own specimens from Windsor for comparison. There is also a *modiola* or *cypricardia*, which may be the shell I have called *avonia*, from Windsor, in Nova Scotia; and a little *cardinia*, like *C. mara*, but not determinable. The most abundant species is a *serpulites*, which is very near *S. annulites*, from Nova Scotia, but the state of preservation is so peculiar that I cannot be sure of it.

"The rock altogether resembles one of those black eroded limestones, which, in Nova Scotia, we find in close proximity to the beds of gypsum, and which are usually very poor in fossils."

Wolf and Shag Islands.

Wolf and Shag Islands, the latter already alluded to as a small, bare rock, are composed of a soft, crumbling, red sandstone, altogether resembling that described as belonging to the upper portion of the formation.

At North Cape the rocks differ somewhat from any of those hitherto described. They consist of grey sandstones, variegated with red and sometimes green spots and blotches, in beds of two to twelve inches in thickness. Towards the base they are interstratified with brownish-red limestone in beds, six to eighteen inches thick; some of the beds at the

base on the north-west side are of a flinty character, the color varying from a dull to a bright red. The dip is about S. 16° W., < 15° to 19°.

North-east Cape.

Very similar rocks are met with in North-east Cape, with the exception of the limestone, which, while occupying the same relative position, is here of a yellowish-white color· On the north-east side of the Cape immense quantities of this rock, associated with blocks of grey sandstone, have fallen from the cliffs. The limestone blocks are stained with a green mineral, which on examination proved to be chromiferous. The dip here, although much obscured by false bedding, is believed to be about west < 10° or 12°.

If these dips are reliable, the rocks of North and North-east Capes would be below Grosse Island, which lies east of the former and about west of the latter, and consequently also below the gypsum-bearing beds, which are exhibited towards the south-west end of Grosse Island, and are accompanied by funnel-shaped depressions, like those already described showing large deposits of gypsum. The associated igneous rocks were not seen on this island, but as it is still largely covered with forests, and considerable stretches of the shore are difficult of access, their presence may have been overlooked.

Age of the formations.

The lower rocks, with their associated deposits of gypsum, are almost certainly a part of the Lower Carboniferous formation, but there are some reasons for supposing that the upper red sandstone overlies them unconformably, and may be of Permian or Triassic age.

Superficial Deposits.

On all the islands visited the relations of the superficial deposits are rather obscure. Nowhere could deposits of clay or gravel be distinguished such as are usually attributed to the drift period. The surface is everywhere covered with a mantle of soil, of similar quality throughout, lying on the upturned edges of the older rocks. The following section, which is in ascending order, indicates the nature of the superficial deposits:—

Section of superficial deposits.

	Feet.	Inch.		Feet.	Inch.
Fine sand, chiefly white quartz, having in the aggregate a red or yellow appearance, caused by an admixture of red and yellow oxides of iron. Thickness from....................	3	0	to	10	0
White, very fine-grained sand..........	0	2	to	0	6
Fine, dark-colored, sandy loam, containing roots of plants. This forms the cultivated soil, and the thickness varies from........................	0	6	to	2	0
	3	8	to	12	6

The average thickness of these deposits is thus about eight feet, and they are remarkable for their uniform character throughout.

On account of the generally soft and friable nature of the rocks, no glacial grooves or scratches are to be seen; whether, therefore, any such ever existed is uncertain, and but little information is to be derived from the presence of drift boulders, they are so scarce everywhere, and on Amherst Island none were observed. On Grindstone Island rounded blocks are met with, at wide intervals, of a hard, white, compact quartz rock, varying in size from a few pounds to nearly one ton in weight. On the travelled road, from one to two miles west of Cap aux Meules, these quartz fragments are most abundant; they are generally from a few pounds to not over forty pounds in weight. Many of these are partly composed of a coarse description of agate, gradually passing externally into an ordinary quartzose rock. Glacial action.

Between Cap l'Eperon and Hospital Point, on Grindstone Island, one part of the beach is packed with moderate-sized, rounded blocks of white quartz and chloritic and micaceous schist, some of which resemble Laurentian rocks. At the extreme south-west point of Wolf Island, the foot of the soft sandstone cliff was found to be partially protected for a space of forty or fifty yards by an accumulation of boulders, which had evidently fallen from the top of the cliff, where they were originally deposited, and closely packed together. These are from 100 pounds to half-a-ton in weight, and of the same character as those above described between Cap l'Eperon and Hospital Point, on Grindstone Island.

Economic Minerals.

Owners of vessels trading to the islands have occasionally taken return cargoes of gypsum, but owing to want of care in selecting the mineral, Magdalen Islands gypsum has acquired an undeserved bad reputation in the Quebec market.

The areas in which the gypsum deposits occur, have already been sufficiently indicated, but three localities may be especially mentioned where it crops out on the shore, apparently in workable quantity, and easily accessible for small vessels in calm weather.

1. *Amherst Island.*—Under Demoiselle Hill, on the beach facing Pleasant Bay, there are several exposures of considerable extent. It is generally of a yellowish-white color, sometimes compact and sometimes granular.

2. *Grindstone Island.*—Between Cap aux Meules and the north-east end of the island.

3. *Alright Island.*—On the south shore, west of Butte Ronde. At one

part of this exposure the gypsum appears to be remarkably pure, very compact, of a light grey color, and apparently free from carbonate.

Manganese.

Manganese.—Immediately under Demoiselle Hill, on Amherst Island, numerous blocks charged with peroxide of manganese, or pyrolusite, occur among the *debris* of the fallen cliffs. They are in pieces varying from one pound to ten or fifteen pounds in weight. There can be little doubt that they are derived from a deposit more or less regular in the hill-side, but which is now completely concealed by the fallen *debris*. At a place bearing nearly due west from Cap aux Meules, at the distance of about a mile, and close to the English Mission Church, similar pieces to those above described are very frequently picked up. Numerous stones of this character were observed by me at this locality, but as the ground was covered with growing crops I did not attempt any further search.

The analysis of these specimens is given in Mr. C. Hoffmann's report, pages 15 H and 18 H.

General Aspect, Soil, Timber, &c.

Surface features.

The surface of the islands presents a very uniform appearance, gently undulating or level, with a few conical hills rising to a height of 200 to 500 feet above the sea. No rocks were observed to protrude through the soil, which everywhere extends from the lowest to the highest levels. The former are occasionally occupied by swampy ground. Except where this occurs, every foot of land is available for cultivation, and wherever this has been carried on with any degree of attention crops of vegetables and grain of all kinds are obtained equal, as far as I could judge, to those of any part of the Dominion.

The principal timber is spruce, occasionally mixed with balsam-fir, white birch and alder. The spruce is mostly of a stunted growth, the trees being densely packed together, rarely exceeding one foot in diameter at the base and twenty feet in height. Owing to the gradual clearing of the land on Amherst, Entry, Alright and Grindstone Islands, wood for fencing and for fuel is getting scarce. On the other islands abundance of timber still remains for all such purposes.

Introduction of trees.

Attempts have been made on a small scale to introduce other trees, principally on Amherst Island, but hitherto without any marked success. When planted in sheltered spots, these exotic trees do well for a year or two, till they attain a height of eight or ten feet, when growth ceases, and they either die or become stunted.

From the size of the islands it would hardly be expected that streams of fresh water could be numerous or large. A few brooks, however, of pure, clear water are met with, two or three feet wide, and consider-

ing their size, it is interesting to know that trout, often over one pound Trout.
in weight are taken in them.

The inhabitants are mostly of French-Acadian descent, with a small intermixture of English, Irish and Scotch. Their dwelling-houses are remarkable for their uniformity of construction, and it is gratifying to note that, if not richly furnished, they are generally scrupulously neat and clean.

A more agreeable sea-side resort than the Magdalen Islands could not easily be found on any part of our coasts. The great extent of clean, sandy beach, backed by deep green sward resembling a well-kept lawn, and the comparatively shallow water, considerably warmer than it generally is on the St. Lawrence, afford unrivalled bathing facilities; while during the months of July and August the weather is bright, moderately warm and bracing. But, unfortunately, the accommodation for visitors is at present very limited, consisting of only a few boarding-houses on Amherst and Grindstone Islands.

APPENDIX.

LIST AND NOTES, BY PROFESSOR MACOUN, OF PLANTS COLLECTED BY MR. RICHARDSON ON THE MAGDALEN ISLANDS.

			Amherst Island.	Grindstone Island.	Grosse Island.
1	Viola cucullata, Ait	August 7	1		
2	Drosera rotundifolia, L	June 26	1		
3	Stellaria media, Smith (introduced)	August 7	1		
4	Cerastium viscosum, L	"	1		
5	Spergula arvensis, L. (introduced)	"	1		
6	Impatiens fulva, Nutt	"	1		
7	Trifolium repens, L	June 26	1		
8	Lathyrus palustris, L	July 25		1	
9	Poterium Canadense, Gray	August 7	1		
10	Fragaria Virginiana, Ehrh	"	1		
11	Potentilla anserina, L	"	1		
12	" tridentata, Ait	July 30	1		
13	" palustris, Scop	August 7	1		
14	Rubus triflorus, Rich	June 26		1	
15	Rosa blanda, Ait	July 28			1
16	Epilobium angustifolium, L	August 7		1	
17	" palustris, var. lineare, Gray	"	1		
18	" coloratum, Muhl	"	1		
19	Sium lineare, Mich	"	1		
20	Carum carui, L. (introduced)	"	1		
21	Cornus Canadensis, L	June 26	1		
22	Galium trifidum, L	August 7	1		
23	Eupatorium purpureum, L	"	1		
24	Aster acuminatus, Michx	"	1		
25	Biplopappus umbellatus, Torr & Gr	August 8	1		
26	Bidens frondosa, L	August 7	1		

			Amherst Island.	Grindstone Island.	Grosse Island.
27	Maruta Cotula, D.C. (introduced)................	August 7	1		
28	Achillæa Millefolium, L........................	"	1		
29	Antennaria Margaritacea, R. B. I................	August 8	1		
30	Senecio vulgaris, L. (introduced)...............	August 7	1		
31	Nabalus altissimus, Hook.......................	"	1		
32	Vaccinium Oxycoccus, L.........................	"	1		
33	" Vitis-Idæa, L....................	"	1		
34	" Pennsylvanicum, L................	June 26	1		
35	Kalmia glanca, Ait.............................	August 7	1		
36	Ledum latifolium, Ait..........................	"			
37	Trientalis Americana, Purch....................	July 31	1		
38	Lysimachia thyrsiflora, L......................	August 8	1		
39	" stricta, Ait.....................	"	1		
40	Veronica Americana, Schw.......................	August 7	1		
41	Euphrasia officinalis, L.......................	"	1		
42	Rhinanthus Crista-galli, L.....................	June 26	1		
43	Lycopus Virginicus, L..........................	August 8	1		
44	Brunella vulgaris, L...........................	August 7	1		
45	Scutellaria lateriflora, L.....................	"	1		
46	Menyanthes trifoliata, L.......................	"	1		
47	Chenopodium album, L. (introduced).............	"	1		
48	Polygonum aviculare, L. "	"	1		
49	" sagittatum, L....................	August 8	1		
50	" Hydropiper, L. (introduced)...........	August 7	1		
51	Spiranthes Romanzoviana, Cham..................	August 8	1		
52	Iris versicolor, L.............................	July 14		1	
53	" " var. alba.........................	July 14		1	

			Amherst Island.	Grindstone Island.	Grosse Island.
54	Sisyrinchium Bermudianum, L	August 30	1		
55	Smilacina trifolia, Desf	August 7	1		
56	" bifolia, Fur	"	1		
57	Luzula campestris, D.C	"	1		
58	Juncus alpinus, Vill., var. insignis, Fries	"	1		
59	" effusus, L	"	1		
60	" filiformis, L	"	1		
61	Scirpus Eriophorum, Mchn	"	1		
62	Eriophorum polystachyon, L	July 15		1	
63	" vaginatum, L	August 7	1		
64	" Virginicum, L	"	1		
65	Carex adusta, Boott	"	1		
66	" canescens, L	"	1		
67	" stellulata	"	1		
68	" stipata, Muhl	"	1		
69	" utriculata, Schk	"	1		
70	Agrostis vulgaris, With	"	1		
71	Calamagrostis Canadensis, Beauv	"	1		
72	Glyceria aquatica, Smith	"	1		
73	Poa compressa, L	"	1		
74	Festuca ovina, L	"	1		
75	Triticum repens, L	August 8	1		
76	Hordeum jubatum, L	August 10	1		
77	Hierochloa borealis, Roem & Sch	August 7	1		
78	Aspidium spinulosum, Swz., var. dilatatum	August 8	1		
79	Osmunda cinnamomea, L	August 7	1		

The collection has evidently been made where there are settlements, as it contains a number of introduced species. Others, again, are coast species, while a few are from thickets or open woods. Swamps or marshes have likewise given their quota; five or six species excepted, the collection might have been obtained anywhere in Ontario or Quebec.

The species shewing an eastern or northern habitat are Canadian Burnet (*Poterium Canadense*), which I obtained in northern British Columbia, and which Dr. Bell brought from near Hudson's Bay. Three-Toothed Cinque-foil (*Potentilla tridentata*) extends up the St. Lawrence and appears on the north shore of Lake Superior and at the north end of Lake Winnipeg and westward to Peace River. An Aster (*Aster acuminatus*) seems to be peculiar to the Maritime Provinces and Quebec, the most western locality given being in the neighbourhood of Ottawa, north of the river. Cow-Berry (*Vaccinium Vitis-Idæa*), so abundant eastwards, is found north of Lake Superior and thence through the damp cold woods to the Pacific Coast. Eyebright (*Euphrasia officinalis*) is also found north of Lake Superior, north-west to Hudson's Bay, and appears again on the Rocky Mountains in Bow River Pass. Common Yellow Rattle (*Rhinanthus Crista-galli*) appears at Lake Superior, Hudson's Bay, Cypress Hills, on Peace River, and westward in northern British Columbia. Wild Barley (*Hordeum jubatum*) appears also at Lake Superior and Hudson's Bay, and is particularly abundant on the borders of salt marshes and ponds in the prairie region of the North-West.

As all the above species have a western habitat, it would have been difficult to locate the collection had it not been for two inconspicuous species—Corn Spurrey (*Spergula Arvensis*) and the Coast Knot Grass (*Polygonum maritimum*)—the latter of which, however, was collected by Dr. Bell along the shore of Hudson's Bay. The Spergula is an English weed, and likely was growing on ballast near the shore.

From the facies of the collection, I would infer that the climate is humid and cool, and scarcely warm enough to ripen wheat, although I may be mistaken on this point, as there are no species in the collection which decidedly indicate that.

BELLEVILLE, ONT., May 23rd, 1881.

GEOLOGICAL SURVEY OF CANADA.
ALFRED R. C. SELWYN, LL.D., F.R.S., F.G.S., DIRECTOR.

CHEMICAL CONTRIBUTIONS

TO THE

GEOLOGY OF CANADA.

FROM THE

LABORATORY OF THE SURVEY.

BY

G. CHRISTIAN HOFFMANN, F. Inst. Chem.

Chemist and Mineralogist to the Survey.

PUBLISHED BY AUTHORITY OF PARLIAMENT

Montreal:
DAWSON BROTHERS.

1881

ALFRED R. C. SELWYN, ESQ., LL.D., F.R.S., F.G.S.,

Director of the Geological Survey of Canada.

SIR,—I have the honor of herewith submitting to you my Report upon the work carried out in the Laboratory of the Survey during the past year. It was deemed desirable—and this to the exclusion of what represented a very appreciable amount of work—that it should include only such analyses or examinations as were considered likely to prove of general interest.

Desirous that my Assistant, Mr. Frank D. Adams, should receive the merit due to his labors, his name has in all instances been attached to the various analyses and examinations made by him;—those not so particularized having been carried out by myself.

I have the honor to be,

Sir,

Your obedient servant,

G. CHRISTIAN HOFFMANN.

MONTREAL, May 1st, 1881.

CHEMICAL CONTRIBUTIONS

TO THE

GEOLOGY OF CANADA,

FROM THE

LABORATORY OF THE SURVEY,

BY

G. CHRISTIAN HOFFMANN, F. Inst. Chem.

MISCELLANEOUS MINERALS.

DISSEMINATED GRAPHITE.

Graphitic shale—From French Vale, Cape Breton, Nova Scotia.

This deposit is situated about half a mile south of Guthro Lake, and near the French Vale road, and, as Mr. Fletcher informs me, occurs in connection with the George River limestone. It is stated to have a thickness of from two to three feet, and to have been traced for some distance. "Disseminated graphite" from Nova Scotia.

An analysis of what appeared to be a characteristic specimen showed it to have the following composition:— Analysis of.

Graphite	38.387
Silica	22.499
Alumina	14.358
Ferric oxide	5.133
Manganese, nickel, cobalt and copper	Traces.
Lime	1.801
Magnesia	8.001
Disulphide of iron (iron pyrites)	0.409
Water, hygroscopic	1.434
" , combined	3.553
Alkalies	Undet.
	95.575

No other constituents, beyond those here enumerated, were sought for. The graphite was separated, and weighed as such. A small proportion of the sulphur found may be present in the form of a sulphate;

"Disseminated graphite" from Nova Scotia, cont.

the whole of this constituent has, however, been calculated as disulphide of iron, the amount of iron required for such combination having been subtracted from the total iron found, the balance of which latter has been represented as ferric oxide.

The powdered rock is readily attacked by strong hydrochloric acid, whose action, at a boiling heat, during a prolonged digestion, dissolved out—for 100 parts of the air-dried material:—

Silica	0.049
Alumina	11.242
Ferric oxide	5.166
Manganese	Traces.
Lime	1.588
Magnesia	7.776

From this it will be seen that the hydrochloric acid treatment effected the removal of by far the greater part of the alumina, nearly the whole of the lime and magnesia, the whole of the iron assumed to be present as ferric oxide, and, in addition, a portion of the iron (but which has here been calculated as, and included in, the number indicating ferric oxide) represented as in combination with the sulphur. The solution also contained a trifling quantity of sulphuric acid; the amount, however, was not estimated; agreeably with the results of other experiments, it varied according to the length of time occupied in the digestion; unless the latter was very prolonged, it never amounted to more than mere traces.

The proximate analysis of this rock gave:—

Graphite	38.387
Rock matter, soluble in hydrochloric acid	31.096
Rock matter, insoluble in hydrochloric acid	29.083
Hygroscopic water	1.434
	100.

The graphite is very evenly disseminated through the rock, and occurs in the form of minute steel-grey colored scales of bright, metallic lustre. On calcining the powdered mineral, the graphite burns away slowly and with some difficulty, leaving a reddish-brown colored ash.

Adaptability of the graphite for the manufacture of lead-pencils and for electrotyping.

The purified graphite extracted from this rock gives a fairly black lustrous streak, and, so far as quality is concerned, would appear to be well adapted for the manufacture of a very fair grade of lead-pencil, for electrotyping, and most, if not all, of the other numerous applications for which graphite is available. Whether it could be advantageously employed for any of these purposes must necessarily depend upon the cost entailed in the extraction and preparation of the graphite of the requisite degree of purity.

INFUSORIAL EARTH OR EARTHY TRIPOLITE.

From Pollet River Lake, Mechanic Settlement, King's County, New Brunswick.

Infusorial earth from New Brunswick.

A detailed statement of the results of the examination of this material appeared in my last report; inasmuch, however, as the analysis possesses an interest in connection with the following experiments, it has also been given here.

The sample had been kept in the dry atmosphere of the laboratory for a lengthened period, and was regarded as perfectly air-dried. It was found that at 100° C., the oxygen of the air exercised a modifying influence upon this material, so that in order to ascertain the correct loss by water at this temperature, it was necessary that, the operation should be conducted in an atmosphere of hydrogen or carbonic acid.

An analysis of the air-dried material gave the following results:— Analysis of.

Silica	80.487
Alumina	3.146
Ferric oxide	0.951
Lime	0.342
Magnesia	0.283
Carbonic acid	0.011
Phosphoric acid	?
Potash and soda	?
Water[1]—combined and hygroscopic—and organic matter	13.321
	98.541

1—Water and organic matter.

a. Loss on drying over sulphuric acid	6.535
b. Loss (in addition to that of *a.*) on drying at 100° C., in a current of pure and dry hydrogen	3.582
c. Loss (in addition to that of *a.* and *b.*) on ignition (and after correction for carbonic acid)	3.204
	13.321

Some of the many useful purposes to which this material might be applied were alluded to on the former occasion. Since then it has been deemed desirable to ascertain experimentally its suitableness for the manufacture of bricks in imitation of the so-called "light or swimming bricks." These latter, owing to the porous nature of the silica composing the material from which they are made, combine great lightness with infusibility, and are remarkably bad conductors of heat, on which account they constitute, for many purposes of construction, a valuable building material.

Its suitableness for the manufacture of bricks.

Manner of conducting the experiments.

Infusorial earth from New Brunswick, cont.

In these experiments the earth was employed alone, as well as in admixture, the addition being in the one case clay (a white pipe-clay), and in the other lime, the material from which the test-bricks were prepared consisting—

In the case of experiment 1. Of the infusorial earth alone.
" " 2. Of a mixture of infusorial earth and clay: 95 parts of the former to 5 of the latter.
" " 3. Of a mixture of infusorial earth and clay: 90 parts of the former to 10 of the latter.
" " 4. Of a mixture of infusorial earth and lime: 99 parts of the former to 1 of the latter.
" " 5. Of a mixture of infusorial earth and lime: 98 parts of the former to 2 of the latter.

The infusorial earth and clay were in an air-dried condition; the lime had been but recently prepared. The amount of dry material and water employed to form the various bricks was in all instances the same. The bricks were all moulded of exactly the same size, and measured 76 mm. in length, 28 mm. in breadth, and 15 mm. in thickness.

A small hand-press was used in the moulding; the pressure employed, however, was not great, and did not very much exceed that which might have been obtained by hand. The freshly moulded bricks having been exposed to a dry atmosphere until they had parted with the greater part of their moisture, were next dried at a temperature of 100° C., after which they were inserted in covered crucibles and placed in an air-furnace, the temperature of which was gradually raised until at the expiration of an hour a white heat had been obtained, at which temperature it was maintained for an additional two hours.

The experiments were carried out in duplicate.

Results.

Refractoriness.—The bricks had in all instances retained their form in perfect tact; they had neither warped nor cracked; their edges remained perfectly sharp, and showed no indication of having undergone even the most incipient fusion. They were all highly absorbent, adhering strongly to the tongue; exceedingly firm, and very tough. Bricks of experiments 1, 4 and 5 appeared to possess this latter property in about an equal degree; they could not be readily broken between the fingers; those of experiment 2 broke only with great difficulty, whilst those of experiment 3 could not be broken in this

wise. The fracture was uneven, in the case of the bricks of experiments 1, 2 and 3, somewhat jagged. The bricks of experiments 1, 2 and 3 presented very smooth surfaces, and possessed a fine and close texture; when suddenly plunged into the flame of a blast-lamp, they decrepitated strongly; this, however, was not the case when the heat was gradually applied. Bricks of experiments 4 and 5 were looser in texture, and when suddenly plunged into the flame of the blast-lamp, stood well; they proved excellent non-conductors of heat: the brick could be held between the fingers, without the slightest inconvenience, whilst the other end was heated to redness in the blast-lamp. **Infusorial earth from New Brunswick, cont.**

Contraction.—The linear contraction (for the temperature and duartion of firing afore-specified) amounted to—in the case of test-brick

Of experiment	1..... 9.87	per cent. of the original	moulded size.
"	2.....11.18	"	"
"	3.....11.18	"	"
"	4..... 9.20	"	"
"	5..... 7.89	"	"

From this it will be seen that the contraction was most marked in those bricks containing an admixture of clay, and least so in those containing an admixture of lime.

Color.—The bricks previous to firing were all perfectly white. After: Those of experiments 1, 2 and 3 were of a uniform cream-color, externally and internally. Those of experiments 4 and 5 were perfectly white; this is in accordance with the fact that the presence of the alkaline earths in ferruginous clays, especially of lime and magnesia, has a singular bleaching power in the kiln, arresting the development of the bright-red color. It has been found that a marl containing six per cent. of ferric oxide and thirty-five per cent. of carbonate of lime, burned of a greyish-buff, instead of the rich red such a proportion of iron would otherwise have produced. Experiment has shown that so small a proportion as five per cent. of caustic magnesia mixed with a red-clay entirely destroys its red-color in the kiln. In the case of the yellow brick, manufactured in the neighborhood of London, England, the colour is dependent on the admixture of ground chalk with the brick-earth, the latter by itself burning of a red color.

Weight—As compared with that of a fire-brick.—The fire-brick measured 9 inches in length, 4½ inches in breadth, and 2½ inches in thickness, and weighed 7 pounds.

From the data obtained in these experiments it was found that a brick of the foregoing dimensions, made under the same conditions and

Infusorial earth from New Brunswick, cont.

from material similar to that employed in the preparation of the test-brick

Of experiment	1	would weigh	3	lbs.	6.2	oz.
"	2	"	3	"	10.9	"
"	3	"	3	"	12.4	"
"	4	"	3	"	1.6	"
"	5	"	3	"	1.9	"

As compared with that of a common brick.—The brick measured 8 inches in length, 3¾ inches in breadth, and 2½ inches in thickness, and weighed 4 pounds 15 ounces.

In like manner it was here found that a brick of these dimensions, made under the same conditions, and from material similar to that from which the test brick

Of experiment	1	was prepared,	would weigh	2	lbs.	10.5	oz.
"	2	"	"	2	"	14.2	"
"	3	"	"	2	"	15.4	"
"	4	"	"	2	"	6.9	"
"	5	"	"	2	"	7.1	"

LIGNITE ASH.

Lignite ash from the Souris River

Taken from the outcrop of a seam of lignite occurring on the right bank of the Souris River, six and a half miles east of La Roche Percée, North-West Territory. Collected by Dr. A. R. C. Selwyn, and referred to by him in his accompanying report.

The specimen received was partly in the form of friable lumps and partly in that of powder; it had a light greyish color, and contained intermingled fragments of lignite; the latter in a perfectly unaltered condition.

Analysis of.

This material, when perfectly freed from the associated lignite, was found by Mr. F. D. Adams to have the following composition:—

Silica	16.482
Alumina	1.790
Ferric oxide	0.908
Lime	24.701
Magnesia	0.173
Alkalies (very small quantity)	Undet.
Sulphuric acid	....
Water	20.682

The sulphuric acid was determined, the results however have not been given, inasmuch as they appeared somewhat too high—the amount found was in excess of that required to enter into combination with the bases.

The associated lignite was also examined by Mr. F. D. Adams. He found it to contain 10.971 per cent. of ash, the analysis of which gave him the following results:— Lignite ash from the Souris River, cont.

Silica	15.358
Alumina	18.388
Ferric oxide	7.542
Lime	23.480
Magnesia	19.170
Alkalies	Undet.
Sulphuric acid	13.437
	97.375

This material would therefore appear to consist of the less soluble constituents of the ash of lignite, the more soluble having been removed by the agency of water. From the fact of the associated lignite being in an unaltered condition, it is most reasonable to suppose that this has subsequently become mixed with the other material.

NATURAL WATERS.

A saline water—From MacMaster's Mill, Victoria road, Queensville, Cape Breton, Nova Scotia. Collected by Mr. Hugh Fletcher. Mineral water from Nova Scotia.

The sample received was perfectly clear and colorless, had a slightly alkaline reaction, and was found by Mr. F. D. Adams to contain about 5.859 parts of dissolved solid matter in 1000.

The qualitative analysis made by him showed it to contain the following bases and acids:— Analysis of.

BASES.

Potassa	A trace.
Soda	A very large quantity.
Lime	A small quantity.
Magnesia	A very small quantity.
Ferrous oxide	A small quantity.

ACIDS.

Sulphuric acid	A rather large quantity.
Phosphoric acid	A trace.
Carbonic acid	A rather small quantity.
Chlorine	A large quantity.

Neither bromine nor iodine were detected.

This water belongs—in accordance with the classification of mineral waters adopted by Dr. T. S. Hunt—apparently to the third class.

COALS.

BITUMINOUS COAL.

Bituminous coal.

1.—The following are the results of the examination of a sample of what was supposed to be coal, but which is really little more than a coaly shale. It occurs on the William Dernier estate, bay shore, Upper Salmon River, Albert County, New Brunswick. The seam from which it was taken is stated to have a thickness of about three feet. Examined for Mr. E. B. Chandler.

The specimen had a crumpled shaly structure, and showed traces of slickensides; in parts contained a very appreciable amount of "mother of coal;" color black; powder brownish-black; lustre varied from dull to brilliant.

Analyses of supposed coal from New Brunswick.

Analyses by slow and fast coking gave the following results:—

	Slow coking.	Fast coking.
Hygroscopic water	0.83	0.83
Volatile combustible matter	20.34	24.20
Fixed carbon	30.60	26.74
Ash	48.23	48.23
	100.	100.
Ratio of volatile combustible matter to fixed carbon	1 : 1.50	1 : 1.10

Notwithstanding the very large proportion of inorganic matter, it yields, by fast coking, a moderately firm, coherent, blackish-grey, dull coke. The gases evolved during coking burnt with a yellow, luminous, somewhat smoky flame. Slow coking gave a pulverulent coke. Color of the ash, light brownish-red.

LIGNITE OR BROWN COAL.

NORTH-WEST TERRITORY.

Lignite or Brown coal.

From the Souris River.

2.—From the Souris River, seven miles east of LaRoche Percée. Taken from a boring at a depth of two hundred and seventy eight and a half feet from the surface. The seam was estimated to have a thickness of about six feet. Age, Tertiary. Collected by Dr. A. R. C. Selwyn.

Color black, with a just perceptible brownish tinge; does not soil the fingers; lustre shining resinous; powder black, with a brownish tinge—the same communicated a deep brownish-red color to a boiling solution of caustic potash.

Analyses by slow and fast coking gave the following results:— Lignite or Brown coal, cont. Analyses of, from Souris River.

	Slow coking.	Fast coking.
Hygroscopic water	17.78	17.78
Volatile combustible matter	29.51	32.70
Fixed carbon	44.36	41.17
Ash	8.35	8.35
	100.	100.
Ratio of volatile combustible matter to fixed carbon	1 : 1.50	1 : 1.26

Both slow and fast coking gave a pulverulent coke. Color of the ash dark brown; it agglutinated slightly at a bright-red heat, and a portion placed on moistened turmeric paper manifested a slight alkaline reaction.

3.—From the Souris River, one mile west of LaRoche Percée, at the junction of Short Creek and Souris River. Seam four feet thick. Age, Tertiary. Collected by Dr. A. R. C. Selwyn. From Souris River.

A brownish-black, compact lignite; ligneous texture very decided; lustre for the greater part dull, in more altered parts sub-resinous to resinous; fracture on the whole uneven, occasionally, however, verging on the sub-conchoidal; tough; does not soil the fingers; on exposure to the air becomes more or less fissured; powder black, with a brownish tinge—it imparted a deep brownish-red color to a boiling solution of caustic potash.

Analyses by slow and fast coking gave as follows:— Analyses of.

	Slow coking.	Fast coking.
Hygroscopic water	21.84	21.84
Volatile combustible matter	32.15	35.12
Fixed carbon	41.61	38.64
Ash	4.40	4.40
	100.	100.
Ratio of volatile combustible matter to fixed carbon	1 : 1.29	1 : 1.10

Both slow and fast coking gave a pulverulent coke. The ash had a brownish-yellow color, agglutinated slightly at a bright-red heat, and when placed on moistened turmeric paper manifested a strong alkaline reaction.

4.—From the Smoky River, five miles below the mouth of Little Smoky River. Seam two and a half inches thick. Collected by Dr. G. M. Dawson. From the Smoky River.

Lignite or Brown coal, cont.

Structure lamellar; made up of alternating layers of a dull and bright lignite and mineral charcoal, of which latter it contained a good deal; small fragments of a pale yellowish, sub-transparent resin also occur, diffused through certain portions of its substance; color black; powder black, with a brownish tinge—the same communicated a deep brownish-red color to a boiling solution of caustic potash.

Analyses of, from Smoky River.

Analyses by slow and fast coking gave :—

	Slow coking.	Fast coking.
Hygroscopic water	11.52	11.52
Volatile combustible matter	31.26	34.83
Fixed carbon	53.04	49.47
Ash	4.18	4.18
	100.	100.
Ratio of volatile combustible matter to fixed carbon	1 : 1.69	1 : 1.42

By fast coking it yields a slightly coherent, by slow coking a pulverulent coke. The ash had a pale reddish-brown color, agglutinated slightly at a bright-red heat, and manifested a strong alkaline reaction when placed on moistened turmeric paper.

From Athabasca River.

5.—From the Athabasca River, about fifty-five miles above the site of old Fort Assineboine. Upper seam; seam ten feet thick. Collected by Dr. G. M. Dawson.

Structure lamellar; contained an occasional interposed layer of mineral charcoal; some of the layers of lignite were reticulated throughout with delicate laminæ of gypsum; fracture uneven; on exposure to the air splits along the line of bedding; color black; lustre of some of the layers sub-resinous, that of others shining resinous; the powder, which was black with a brownish tinge, communicated a deep brownish-red color to a boiling solution of caustic potash.

Analyses of.

Analyses by slow and fast coking gave as follows :—

	Slow coking.	Fast coking.
Hygroscopic water	11.47	11.47
Volatile combustible matter	28.96	32.09
Fixed carbon	50.92	47.79
Ash	8.65	8.65
	100.	100.
Ratio of volatile combustible matter to fixed carbon	1 : 1.76	1 : 1.49

Both slow and fast coking gave a pulverulent coke. Color of the ash light bluish-grey, it agglutinated but very slightly at a bright-red heat, and manifested but a faint alkaline reaction when placed on moistened turmeric paper. Lignite or Brown coal, cont.

6.—From the Athabasca River, about fifty-five miles above the site of old Fort Assineboine. Lower seam; seam three feet thick. Collected by Dr. G. M. Dawson. From Athabasca River.

Structure lamellar; made up of successive layers of a bright and dull lignite, with an occasional intervening layer of mineral charcoal; fracture uneven; color black; on exposure to the air it has a tendency to split in the direction of the bedding; powder black, with a brownish tinge—it communicated a deep brownish-red color to a boiling solution of caustic potash.

Analyses by slow and fast coking gave the following results:— Analyses of.

	Slow coking.	Fast coking.
Hygroscopic water	10.58	10.58
Volatile combustible matter	29.29	32.79
Fixed carbon	53.69	50.19
Ash	6.44	6.44
	100.	100.
Ratio of volatile combustible matter to fixed carbon	1 : 1.83	1 : 1.53

Both slow and fast coking yield a pulverulent coke. The ash had a light grey color; it agglutinated but very slightly at a bright-red heat; a portion placed on moistened turmeric paper manifested a slight alkaline reaction.

7.—From Crowfoot Creek, Bow River. Seam six feet thick. Collected by Professor Macoun. From Bow River, (Crowfoot Creek.)

Structure lamellar; reticulated throughout with delicate laminæ of gypsum; by simple exposure to the air does not fall to pieces; when pressed between the fingers it readily parts into small fragments, the line of fracture being determined apparently by the films of gypsum; fracture uneven; color black; lustre bright; powder black, with a brownish tinge—the same communicated a deep brownish-red color to a boiling solution of caustic potash.

Lignite or Brown coal, cont.

Analyses of, from Bow River, (Crowfoot Creek.)

Analyses by slow and fast coking gave as follows:—

	Slow coking.	Fast coking.
Hygroscopic water	11.25	11.25
Volatile combustible matter	31.98	35.59
Fixed carbon	50.85	47.24
Ash	5.92	5.92
	100.	100.
Ratio of volatile combustible matter to fixed carbon	1 : 1.59	1 : 1.33

Both slow and fast coking gave a pulverulent coke. Color of the ash pale brownish-yellow, it agglutinated slightly at a bright-red heat, and manifested a faint alkaline reaction when placed on moistened turmeric paper.

From Bow River, (Blackfoot Crossing.)

8.—From Bow River, Blackfoot Crossing. Collected by Professor Macoun.

Structure lamellar; contained an occasional layer of mineral charcoal; color black; lustre of freshly fractured surface, bright; on exposure to the air shows a slight tendency to split along the line of bedding, some of the layers of lignite were reticulated throughout with films of gypsum, such, on pressure, crumbled somewhat readily into small fragments; color of powder black, with a brownish tinge—it communicated a deep brownish-red color to a boiling solution of caustic potash.

Analyses of.

Analyses by slow and fast coking gave the following results:—

	Slow coking.	Fast coking.
Hygroscopic water	10.72	10.72
Volatile combustible matter	29.26	32.63
Fixed carbon	46.09	42.72
Ash	13.93	13.93
	100.	100.
Ratio of volatile combustible matter to fixed carbon	1 : 1.57	1 : 1.31

Both slow and fast coking gave a pulverulent coke. The ash had a reddish-white color, agglutinated but very slightly at a bright-red heat, and manifested no reaction when placed on moistened turmeric paper.

PROVINCE OF BRITISH COLUMBIA.

9.—From the Pine River, five miles above the lower Forks. Taken from the two-feet seam. Age, Cretaceous. Collected by Dr. A. R. C. Selwyn, and referred to by him in his report. (Report of Progress 1875-76, p. 53.) Lignite or Brown coal, cont. From Pine River.

Structure lamellar, though not always very distinct; does not soil the fingers; hard and firm; lustre of fracture parallel to the bedding dull, that of the fracture across the bedding shining resinous, occasionally brilliant; fracture uneven; contains a brownish-yellow sub-transparent resin, chiefly in small particles, diffused through its substance; resists exposure to the air; color black; powder very dark-brown, inclining to blackish-brown—it communicated only a just perceptible brownish-yellow tinge to a boiling solution of caustic potash. In appearance very closely resembled coal of the Carboniferous system. This may be regarded as a valuable fuel for many purposes. As already stated, it does not—judging from the sample received—disintegrate on exposure to the air, and is sufficiently hard and firm to render it easy of transportation.

Analyses by slow and fast coking gave:— Analyses of.

	Slow coking.	Fast coking.
Hygroscopic water	2.45	2.45
Volatile combustible matter	27.87	33.76
Fixed carbon	54.58	48.69
Ash	15.10	15.10
	100.	100.
Ratio of volatile combustible matter to fixed carbon	1 : 1.96	1 : 1.44

By fast coking it yields a firm, compact and lustrous coke, the caking being doubtless due to the presence of the resin; slow coking gave a pulverulent coke. Color of the ash white, a portion placed on moist turmeric paper manifested no reaction, it did not agglutinate at a bright-red heat, and was very difficultly fusible before the blow-pipe.

10.—From the Pine River, Coal Brook, two and a half miles east of the lower Forks. Seam six inches thick. Age, Cretaceous. Collected by Dr. G. M. Dawson. From Pine River, Coal Brook.

Structure lamellar; lustre sub-resinous to shining resinous, occasionally in parts brilliant; resists exposure to the air; hard

Lignite or Brown coal, cont.

and firm, though perhaps somewhat less so than the preceding specimen; fracture irregular; weathered surfaces in places coated with ferric hydrate; does not soil the fingers; color black; powder brownish-black—the same communicated a deep brownish-red color to a boiling solution of caustic potash. This may be regarded as a lignite of superior quality; in its general appearance it much resembled coal of the Carboniferous system.

Analyses of, from Pine River, Coal Brook.

Analyses by slow and fast coking gave the following results:—

	Slow coking.	Fast coking.
Hygroscopic water	7.83	7.83
Volatile combustible matter	30.55	34.21
Fixed carbon	55.75	52.09
Ash	5.87	5.87
	100.	100.
Ratio of volatile combustible matter to fixed carbon	1 : 1.82	1 : 1.52

Both slow and fast coking gave a pulverulent coke. Color of the ash reddish-white, it manifested no reaction when placed on moist turmeric paper, agglutinated but very slightly at a bright-red heat, and was difficultly fusible before the blow-pipe.

IRON ORES.

PROVINCE OF NOVA SCOTIA.

Iron ores—Analyses of.

Micaceous iron ore. From Middle River, Nova Scotia.

1.—Micaceous iron ore—From Gairloch Mountain, Middle River, Cape Breton. Collected by Mr. Hugh Fletcher, who informs me that it occurs at or near the contact of the Carboniferous conglomerate and pre-Cambrian felsites; that it has been worked to some extent, but probably does not occur in large quantity.

This sample was coated with a thin layer of purplish-red hæmatite, soiling the fingers. It proved to be an exceedingly pure ore. A partial analysis showed it to contain:—

Ferric oxide	97.564
Water, hygroscopic	0.017
Insoluble residue	1.225
Metallic iron	68.295

Micaceous iron ore. From Guysborough County, Nova Scotia.

2.—Micaceous iron ore—Collected by Mr. Hugh Fletcher, by whom I was informed that it occurs as an irregular deposit at the contact of the Devonian (?) and Lower Carboniferous formations, near Stewart Pond, Guysborough County.

This specimen contained numerous fragments of calcareous and other rock matter, notably of the former, the powdered mineral effervescing strongly with acid. It was found to contain:— Iron ores—Analyses of, cont.

Ferric oxide	58.874
Water, hygroscopic	0.019
Insoluble residue	18.580
Metallic iron	41.212

PROVINCE OF QUEBEC.

3.—On Mr. James Richardson's return from a geological reconnaisance of the Magdalen Islands, that gentleman handed me several specimens of rounded nodules, which, as he informed me, occur amongst the *debris* of the fallen cliff immediately under Demoiselle Hill, on Amherst Island. These nodular masses are of very irregular shape and size; they also, judging by the specimens received, differ greatly in composition—some consisting of a compact hæmatite, whilst others were composed almost entirely of manganite. The results of the examination of one of these latter will be found given under Manganese Ores, Analysis No. 3. Mr. F. D. Adams has made a partial analysis of one of the former, determining the more important constituents, and found it to contain:— Hæmatite from Amherst Island, Magdalen Islands.

Ferric oxide	65.201
Manganous oxide	1.559
Phosphoric acid	0.090
Sulphuric acid	0.396
Water, hygroscopic	0.407
Insoluble residue	0.671
Metallic iron	45.641
Phosphorus	0.039
Sulphur	0.158

PROVINCE OF ONTARIO.

4.—Magnetic iron ore—From the east half of the sixth lot of the tenth range of the township of Fitzroy, in the County of Carleton. This and the following specimen were received from Mr. J. A. Gemmill. Magnetite from the County of Carleton, Ontario.

Massive, structure compact. Color greyish-black. Strongly magnetic. In some of the fragments constituting this sample the cleavage was very perfect. This specimen was in parts coated with ferric hydrate; it also contained occasional angular cavities more or less completely filled with the same mineral, and which would, in this instance, appear to have resulted from the decom-

Iron ores—Analyses of, cont.

position of iron pyrites, unaltered fragments of the latter being occasionally found in some of the cavities. It contained :—

Ferric oxide	57.873
Ferrous oxide	31.159
Titanium dioxide	5.290
Water, hygroscopic	0.046
Insoluble residue	2.829
Metallic iron, total amouut of	64.746

Magnetite from the County of Carleton, Ontario.

5.—Magnetic iron ore—From the same lot and range of the township of Fitzroy as the preceding.

The specimen consisted of fragments of a fine-granular, dark-grey to greyish-black rock. When pulverized it was separable into a magnetic and non-titaniferous portion and a non-magnetic titaniferous portion. A fragment of the same was submitted to a prolonged digestion with concentrated hydrochloric acid, which effected the removal of the magnetic oxide, leaving behind a more or less friable mass, loosely held together, as it appeared, by a delicate net-work of silica, and consisting for the greater part of a greyish-green colored mineral, apparently pyroxene, some ilmenite, a few grains of colorless, transparent quartz, and here and there a few specks of iron pyrites. A partial analysis gave :—

Ferric oxide	19.841
Ferrous oxide	11.512
Titanium dioxide	present, but not estimated.
Water, hygroscopic	0.207
Insoluble residue	59.757
Metallic iron, total amount of	22.843

NORTH-WEST TERRITORY.

Clay iron-stone from Smoky River, North West Territory.

6.—A specimen of clay iron-stone from the Smoky River, seventeen miles above little Smoky River. Collected by Dr. G. M. Dawson.

Structure, very compact; color, dark brownish-grey, inclining to reddish-brown on weathered surfaces; lustre, dull, earthy; tough; fracture, conchoidal.

A partial analysis of this ore, by Mr. F. D. Adams, gave :—

Ferrous oxide	38.562
Ferric oxide	1.414
Water, hygroscopic	0.840
Insoluble residue	15.948
Metallic iron, total amount of	30.983

COPPER ORES.

1—Supposed copper ore—From the brook, one mile and a half north of Whycocomagh village, Inverness County, Cape Breton, Nova Scotia. Received from Mr. Hugh Fletcher. Copper ores—Analyses of, From Inverness County, Nova Scotia.

It consisted of a mixture, almost in equal proportions, of a very fine granular, almost compact, somewhat bluish-black magnetite, and a dark-green fibrous hornblende, with here and there a slight incrustation of green carbonate of copper, and in parts a little copper pyrites. Weight of sample, five and three-quarter pounds. It was found to contain:

Copper .... 0.206 per cent.

It was, by request, also assayed for gold and silver. (Gold and Silver Assays, No. 3.)

2.—From the third lot of the seventh range of the township of Ely, County of Shefford, Quebec. This specimen was received from and examined for Mr. J. R. Woodward; it was not asserted to be an average sample. From the County of Shefford, Que.

It consisted of chalcocite, in a gangue of dolomite and quartz, and contained:

Copper.................................. 46.140 per cent.

It was also examined for silver, and the results will be found given under Gold and Silver Assays, No. 5.

MANGANESE ORES.

1.—From the Mira Hills, on the Salmon River road, about two miles east of the head of Loch Lomond, Cape Breton County, Nova Scotia. This and the following specimen were received from the Hon. E. T. Moseley, Esq. Manganese ores—Analyses of.

The specimen consisted of pyrolusite with a little manganite. It was examined by Mr. F. D. Adams, and found—after drying at 100° C.—to contain: Pyrolusite from the Mira Hills, Nova Scotia.

Manganese dioxide......................... 81.52 per cent.

2.—Another specimen from the same locality as the last, and consisting almost exclusively of pyrolusite, also examined by Mr. F. D. Adams, was found—after drying at 100° C.—by him, to contain: Pyrolusite from the Mira Hills, Nova Scotia.

Manganese dioxide	88.98	per cent.
Ferric oxide	0.21	"

Manganese ores—Analyses of, cont.

Assuming this sample to have fairly represented the average character of the deposit, it may be said to be an ore of excellent quality, and, apart from the chief use for which manganese ore is employed, would—owing to its comparative freedom from iron—be especially well adapted for employment as a decolorizing agent in the manufacture of glass.

Manganite from Amherst Island, Magdalen Islands.

3.—Manganite—From Amherst Island, Magdalen Islands. Collected by Mr James Richardson. This specimen has already been referred to under Iron Ores, Analysis No. 3. It consisted of an irregular shaped nodule, which, when broken, exhibited a finely crystalline structure. Mr. F. D. Adams, who examined this sample, found it to contain available

Manganese dioxide	45.61 per cent.
Water, hygroscopic	0.10 "

GOLD AND SILVER ASSAYS.

The following assays were all conducted by Mr. Frank D. Adams.

PROVINCE OF NOVA SCOTIA.

Gold and Silver assays.

Province of Nova Scotia.

1.—From the Meagher Grant settlement, on the Musquodoboit River.

This specimen was forwarded for examination by Mr. W. H. Weeks, of Dartmouth, N.S. It consisted of mispickel in a gangue of quartz. Assay showed it to contain :

Gold	Traces.
Silver	None.

2.—From Musquodoboit.

Examined for Mr. W. H. Weeks, of Dartmouth, N.S. A fine crystalline mispickel associated with a greyish-white, vitreous, sub-translucent quartz. It was found to contain :

Gold	0.146 ounces to the ton of 2,000 lbs.
Silver	0.277 " " " "

3.—From the brook, one mile and a half north of Whycocomagh village, Inverness County, Cape Breton.

This specimen will be found described under Copper Ores, No. 1. Assays showed it to contain :

Neither gold nor silver.

PROVINCE OF NEW BRUNSWICK.

4.—From Charley Lake road, parish of Canterbury. Gold and Silver assays, cont.

Collected by Mr. Wallace Broad. A vitreous quartz, stained with ferric hydrate. Province of New Brunswick.

It contained neither gold nor silver.

PROVINCE OF QUEBEC.

5.—From the third lot of the seventh range of Ely. Province of Quebec.

This specimen has been described under Copper Ores, No. 2. It was found to contain :

Gold	Traces.
Silver	1.094 ounces to the ton of 2,000 lbs.

PROVINCE OF ONTARIO.

6.—From the south-west quarter of the fourteenth lot of the eighth range of the township of Fitzroy, in the County of Carleton. Received from Mr. J. A. Gemmill. Province of Ontario.

The specimen consisted of galena associated with calcite. The galena entirely freed from the gangue, gave on assay :

Silver .... 2.129 ounces to the ton of 2,000 lbs.

7.—From the Spanish River, about fifty miles up.

Sent for examination by Mr. E. Wright, of Hull, P.Q.

The specimen consisted of a highly weathered schist, containing a little copper pyrites, and in parts stained with green carbonate of copper. It was found on assay to contain :

Silver (with traces of gold) 0.087 ounces to the ton of 2,000 lbs.

8.—From the same locality as the preceding, and received at the same time.

A schist, impregnated with copper pyrites, and with here and there a slight incrustation of green carbonate of copper. Assay showed it to contain :

Silver (with decided traces of gold) 0.219 ounces to ton of 2,000 lbs.

9.—From Marmora ?

The specimen consisted of mispickel associated with quartz. It was found to contain :

Gold	4.739 ounces to the ton of 2,000 lbs.
Silver	0.262 " " " "

Gold and Silver assays, cont.

10.—From the ninth lot of the eleventh range of the township of Dalhousie. Forwarded for examination by Mr. J. W. Morris. It consisted of iron pyrites (and which constituted 67.1 per cent. by weight of this specimen) in a gangue of white, somewhat finely crystalline-granular dolomite, in parts much stained with hydrated peroxide of iron.

It contained neither gold nor silver.

PROVINCE OF BRITISH COLUMBIA.

Province of British Columbia.

11.—From the "Sterling Mine," Kokesaila River, Cowichen district, about thirty-five miles by trail from Victoria.

A fine crystalline galena, with a little copper pyrites, in a gangue of dolomitic limestone and quartz. The gangue constituted nearly, if not quite, half the bulk of the specimen. It was found to contain:

Gold	Distinct traces.
Silver	9.844 ounces to the ton of 2,000 lbs.

12.—From the same locality as the last.

A fine crystalline galena associated with a little copper pyrites and a small quantity of dolomitic limestone. It was found on assay to contain:

Gold	Distinct traces.
Silver	19.323 ounces to the ton of 2,000 lbs.

13.—From the same locality as No. 11.

The specimen consisted of a fine crystalline galena, a little copper pyrites, and a small quantity of dolomitic limestone. This on assay gave:

Gold..................	Distinct traces.
Silver..................	8.021 ounces to the ton of 2,000 lbs.

14.—From the same locality as No. 11.

A fine crystalline galena, associated with a little copper pyrites, in a gangue of dolomitic limestone. The gangue constituted rather more than half the bulk of the specimen. It was found to contain:

Gold	Distinct traces.
Silver	5.104 ounces to the ton of 2,000 lbs.

MISCELLANEOUS EXAMINATIONS.

1.—A specimem of pyrrhotite, labelled, "Nickel ore, from the eleventh range of Sutton, P.Q., was examined for Mr. Alvy Draper, and found by Mr. F. D. Adams to contain: Miscellaneous examinations.

In addition to traces of copper, a little nickel and traces of cobalt.

2.—Mineral specimen from the ninth range of the township of Madoc, County of Hastings, Ontario. It consisted of iron pyrites, associated with hornblende and chlorite, in a gangue of quartz. Examined at the request of the sender, was found by Mr. F. D. Adams to contain:

A very trifling amount of copper and a trace of cobalt.